Next stop climate neutrality

Key questions for the 2040 climate target governance

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List of Abbreviations

2040 CTP	The 2040 Climate Target Plan by the European Commission
AEA	Annual Emission Allocation
AFOLU	Agriculture, forestry and land-use
ALU	Agriculture and land-use
ASCM	Agreement on Subsidies and Countervailing Measures
BECCS	Bio energy and CCS
BioCCS	CCS of biological CO_2 (BECCS and CO_2 from biogas upgrading facilities)
CAP	Common agriculture policy
CCS	Carbon capture and sequestration
CCU	Carbon Capture and Usage
CDR	Carbon Dioxide Removal
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DAC	Direct air-capture
DACCS	Direct air-capture and CCS
ECL	European Climate Law
EEA	European Economic Area
ESABCC	European Scientific Advisory Board on Climate Change
ESR	Effort sharing regulation
EU ETS 1	EU Emissions Trading Scheme covering power plants and industrial installations
EU ETS 2	EU Emissions Trading Scheme covering buildings and road transport fuels
FF55	The Fit for 55 package proposed by the EU Commission
GHG	Greenhouse Gases

GWP	Global Warming Potential
ICAO	International Civil Aviation Organization
ICE	Internal combustion engine
IMO	International Maritime Organization
LRF	Linear Reduction Factor
LULUCF	Land Use, Land-Use Change and Forestry
MSR	Market Stability Reserve
NDC	Nationally Determined Contributions
NECP	National energy and climate plan
SCF	Social Climate Fund
WAM	With additional measures
WEM	With existing measures

Summary of the key questions for the 2040 climate target governance

The aim of this paper is to identify and assess some of the crucial issues which will need to be addressed during the development of the 2040 climate governance. For each topic, it provides some background information and analysis and then looks into open questions to be resolved when setting and implementing the 2040 target. The scope of this paper is limited to GHG emissions from all sectors except LULUCF. Energy efficiency and renewable energy targets – despite their close linkage to the 2040 climate target – are not covered.

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Overview of key questions

2040 target and sectoral distribution:

- **Scope of the target**
  - What will be the scope of the target with regards to international transport emissions, including from a methodological standpoint?
- **Target level**
  - What is the appropriate target level taking into account considerations of feasibility and fairness, as well as the potential inclusion of international transport?
- **Sectoral contributions and targets**
  - Should the EU include indicative or binding sector targets and where should be established (e.g. the Effort Sharing Regulation, the Governance Regulation, the EU Climate Law, the ETS Directive)?
  - Given uncertainties about the individual sector contributions, how should they be established and defined? Should these sector targets be minimum contributions for each sector, or ensure target delivery?
  - Should sector targets be aligned with the current ETS 1, ETS 2 and ESR framework? If not, how would this inconsistency be dealt with and what implications would it have for these instruments (e.g. the merging of ETS 1 and ETS 2)?
- **Role of carbon dioxide removals**
  - Should the EU establish carbon dioxide removal (CDR) targets for 2040 or only one net target including both emissions and removals?
  - Should a separate CDR target be differentiated by technology?
- **Role of international credits**
  - Should the EU establish a separate target for emissions reductions using international credits under Art. 6 of the Paris Agreement outside of the scope of the EU target to serve as a climate finance mechanism and raise climate ambition?
  - How should linking with other ETS (e.g. Switzerland) be treated when determining the domestic target?

ETS 1:

- **Coverage**
  - Maritime transport: Should the coverage be expanded to include smaller shipping vessels and additional pollutants such as black carbon emissions?
  - Aviation: Should the coverage be expanded to non-CO_2 emissions and additional international routes?
  - Waste incineration: Should the coverage be expanded to include municipal waste incineration installations?
  - Smaller installations: Should smaller installations (below 20 MW total rated thermal input) be included in the ETS 1 - taking them out of the ETS 2? What MRV and administrative compliance issues would need to be considered?
  - Negative emissions: Should negative emissions be covered by emissions trading?

- **Overall ambition: Cap decline and inclusion of negative emissions**
  - How can the "ETS endgame" – the period where the supply of emissions allowances approaches zero – be managed given the difficulties of reducing emissions and thus the continued existence of residual emissions falling under the ETS 1?
  - What complementary policies are needed to help scale up negative emissions projects and minimize or even eliminate the gap between the ETS cap and residual emissions in 2040?
  - After complementary policies have been strengthened to the maximum extent, should the rate of the cap decline be adjusted from 2035 and/or the long-term allowance supply be stabilised at a level above zero?
  - Should negative emissions be directly or indirectly included in the ETS 1? If indirect inclusion is chosen, which institution would serve as intermediary between the ETS 1 and the negative emissions projects (e.g. the Market Stability Reserve or a European Carbon Central Bank)?
- **The Market Stability Reserve (MSR)**
  - Does the MSR need to be reformed for the period after 2030 to avoid volatility in the ETS market on either the upside, the downside or both?
  - Is the current MSR design fit for net-zero? What alternative design would be more suited for the ETS end-game?
  - Should the MSR thresholds be updated regularly to reflect the changing realities of the market and the accelerated decline of free allocation for sectors covered by the Carbon Border Adjustment Mechanism (CBAM)?
  - Should there be a price floor to provide certainty for investments?
- **Auction quantities**
  - Should free allocation be reduced further to free up additional amounts for auctioning, e.g. through the inclusion of additional products into the CBAM and a phase-down of free allocation for these emissions?
  - Should the mechanism for invalidating allowances under the MSR be changed to reduce the difference between the allowances released and the allowances taken in by the MSR?

- **Revenues and EU ETS funds**
  - Should the EU set more restrictive rules for the use of ETS revenues to ensure they are used for purposes that primarily and directly support decarbonisation?
  - Should part of the revenues from the CBAM be returned to international climate finance facilities to the benefit of Least Developed Countries, in order to secure global acceptance for the mechanism while also honouring the EU's international climate commitments under the Paris Agreement?
  - How can the EU and member states optimise the spending of ETS revenues across various strategic priorities? Put differently, given current budget constraints and large demands for ETS revenues, how can it be avoided that ETS revenues are spread thinly and support many objectives ineffectively, rather than achieving one or two goals effectively?
- **Carbon Leakage protection for industries, free allocation, and carbon border adjustment**
  - Which additional industrial sectors currently receiving free allocation should be included in the CBAM from 2030 onwards and at what rate?
  - If no export rebate is adopted under the CBAM, what policies can be used to reduce the carbon leakage risk for exporting industries?
  - How can the international relations aspects of the CBAM be managed?
- **Emission factor for biogenic CO2**
  - Should the zero-rating of sustainable biomass in the ETS continue or should all biomass be treated like fossil fuels?

ETS 2:

- **Scope**
  - How should the future framework take into account CO_2 and non-CO_2 emissions (i.e. N_2O and CH_4) from the combustion of fossil fuels that are currently not covered by the ETS 1 or ETS 2? Should fossil CO_2 emissions from the Agriculture, Forestry and Fishing be integrated into the ETS 2, a possible ETS 3 for agriculture, or should they remain solely covered by the ESR?
  - How should the future framework address upstream emissions from fuel production, transportation, distribution, and post-meter leakage that are also not covered by the EU ETS? Should the scope of the ETS 1 or ETS 2 be expanded to cover these emissions, or are these emissions already sufficiently governed by the recently agreed Methane Regulation?
  - If upstream emissions from fuels are to be governed by the Methane Regulation, how would it need to be strengthened and complemented to address upstream emissions from, e.g. biomethane and hydrogen, that are not covered by the Regulation?
  - Some emissions from combustion especially in aviation and shipping are not yet included in either ETS. In part, these emissions also fall outside the ESR, such that they are not covered by any target. The ETS 2 already includes stationary combustion installations in sectors which participate in the ETS 1 but fall below the minimum size thresholds. Similarly, should the ETS 2 be extended to the emissions from aviation and shipping not yet covered by the ETS 1?

- **Cap and linear reduction factor (LRF)**
  - If left unchanged, the Linear Reduction Factor under the ETS 2 means the ETS 2 cap would reach zero by 2044. Even very ambitious climate pathways are not able to remain below the ETS 2 cap, in particular after 2035. Remaining below the ETS 2 cap will thus require a significant acceleration of climate action in the transport and buildings sectors up until 2044. Should an adjustment of the LRF for the period after 2030 or 2035 also be considered to reflect that not all emissions from fossil fuels in the ETS 2 sectors are likely to be abated by 2044?
- **Price containment mechanisms**
  - The Market Stability Reserve for the ETS 2 will initially be filled with 600 million allowances, which are to become invalid on 1 January 2031. At the same time the price containment mechanism set up to keep the ETS 2 price in check will likely be a major draw on the MSR 2 before this date. Will the MSR 2 need to be refilled before or after this date, and if so how could it be done in a way that avoids a significant reduction in climate ambition?
  - Which EU and national companion policies could help to serve as alternative price containment policies, while maintaining and reinforcing climate ambition? How can these policies be implemented sufficiently early and at scale to have a noticeable effect well before 2040?
- **Auction revenues and the Social Climate Fund (SCF)**
  - Will the Social Climate Fund continue after 2032 and, if so, what methodology would be used to determine the relative contribution of each Member State, as well as the ETS 1 vs ETS 2 to its financing?
  - Should the parameters of the SCF (size, distribution key) be kept or updated?
- **Impact of the ETS 2 on ESR targets**
  - Under the 2030 climate policy architecture, lower-income Member States may be able to achieve additional revenues from selling surplus ESR AEA allowances to higher-income Member States with more ambitious national targets. In the post-2030, can and should differentiated national targets under the ESR serve as an additional support for lower-income Member States to achieve emissions reductions in line with the ETS 2 cap?
- **Impact of the ETS 2 on poorer Member States**
  - The Social Climate Fund has been capped at 65 billion Euro, which reflects roughly 25% of auctioning revenues at EU ETS 2 price of 50 EUR/t. Should the size of the SCF be expanded to reflect the need to scale support targeted to lower-income households and member states in line with higher expected carbon prices?
- **Integration of ETS 1 and 2**
  - Should the ETS 1 & ETS 2 be merged, be kept as completely separate systems or partially linked through a limited flexibility?
  - If the systems are partially or fully merged, how can the risk of excessive prices in some sectors and delaying transformation in other sectors. Would merging increase the risk of carbon leakage in energy intensive industries due to excessive prices?
  - How could the upstream (ETS 2) and downstream (ETS 1) monitoring systems be merged into one system?
  - How can the two MSR systems be merged into one system?
  - How would the setting of a combined cap and the distribution of auctioning quantities across Member States work in a combined system?

Agriculture:

- **Options for the period after 2030**
  - How should the EU regulate agriculture emissions in the post-2030 framework?
    - *Option 1: A target-based approach without pricing*, for example by (a) continuing the ESR, (b) setting sectoral targets for agriculture or (c) establishing a new land-use sector regulation and setting an integrated AFOLU (agriculture, forestry and land-use) target that merges agriculture and land-use. If Option 1(c), should separate targets for emissions in agriculture, emissions in land use and carbon removals be considered? Should forests rather be excluded, i.e. would an ALU (agriculture and land-use) sector be a better alternative?
    - *Option 2: Pricing agricultural emissions via taxes or levies*. How would a fixed price for agricultural emissions, e.g. CH_4 from the digestion of ruminants or N_2O from nitrogen fertilization, be determined and how would periodic adjustments to the price level be made? How would the state revenues from such a system be used?
    - *Option 3: Integrate agriculture emissions into the ETS 2 post-2030*. How would the ETS 2 cap be adjusted to make additional emission allowances available to the agricultural sector?
    - *Option 4: Introduce a new emissions trading system*. Next to agriculture emissions, would such a system also cover other emissions, e.g. all or parts of the sectors in the current ESR that are not yet subject to a successor regulation?

- **Technical aspects of an EU ETS for agricultural entities - Inclusion of natural sinks**
  - Who should be obliged to participate in this emissions trading system? Should the obligation be placed: (a) upstream, for example on the manufacturers/traders of nitrogen mineral fertilizers; (b) downstream at the processing level, for example dairy companies; or (c) directly on farms?
  - What emissions should the system cover? CH_4 and N_2O from livestock, N_2O from soils, CO_2 from peatlands?
  - What size entities should be obligated to participate in emissions trading? Should a de minimis threshold be introduced to keep the administrative burden within reasonable limits for smaller farms and companies?
  - If the costs of such a system are passed on to consumers, what import or export protections would be needed to ensure that agricultural commodities are not put at a competitive disadvantage?
  - Should allowances be allocated via auctioning or for free?
  - What should the revenues generated by the ETS be used for? How could they be used to support measures for climate protection and/or climate adaptation? Would they be integrated into the Common Agriculture Policy (CAP)?

  - How could distributional questions between and within Member States from the system be addressed? Should part of the ETS revenues be reserved for lower-income Member States or go to the Social Climate Fund to be used to help vulnerable farmers and consumers?
  - Should carbon sinks be included in the system?
- **Other ESR emissions – Waste**
  - What are the key process emissions covered by the ESR, but not covered by the ETS or F-Gas regulation and what policies are best places to address them?
  - What additional EU policies next to the Landfill Directive and the potential inclusion of waste incineration in the ETS 1 from 2028 onwards are needed to address non-CO_2 emissions from waste management?
  - Can and should any process emissions or emissions from waste management be included in one of the ETS systems?
- **Future of the ESR**
  - What is the future of the ESR post-2030 given that (a) the majority of emissions in the ESR will be covered by emissions trading under the ETS 2 from 2027, (b) the ESR will be dominated by agriculture and other non-CO_2 emissions by 2040, and (c) agriculture emissions may be included in a new ETS 3 or merged with LULUCF sectors to form a new A(F)OLU land-use sector?
  - Should the ESR continue to exist in its current scope post-2030 in parallel to the EU emissions trading systems in order to serve as a safeguard for the ETS 2 by acting as a driver for national climate action, including complimentary policies that will keep the carbon price in check?
  - Could national economy-wide targets for 2040 which are based on national climate-neutrality targets replace the ESR?
  - If the ESR is continued, several important questions will need to be clarified: (a) how would national targets be determined?; (b) would a strong differentiation between Member States be possible given all EU Member States must achieve climate-neutrality by 2050?; (c) how can the ESR compliance mechanisms be strengthened?; (d) are additional flexibilities needed given the scale of the emission reductions needed by 2040?
  - If the ESR is kept, what new transparency and price finding mechanisms will be needed for AEA trading between Member States?
  - If continued, could the ESR realistically serve as an additional source of revenues through AEA sales for lower-income Member States in the period post-2030, or would this no longer be possible?
  - If the ESR is not continued in its current form, how should the post-2030 framework look like for the emissions currently covered by the ESR? Should the ETS 2 be taken out of the ESR (and potentially extended to all remaining energy-emissions) and the ESR continued in a much smaller scope dominated by agriculture? Should the ESR be discontinued and replaced by new, strengthened sectoral regulation and other policies in the sectors outside of the ETS, complemented by the integration of additional ESR emissions into EU emissions trading?

Negative emissions / Carbon Dioxide Removal:

- **Governance and financing of CDR**
  - Carbon Dioxide Removals will play an important role in delivering climate-neutrality by 2050 and net-negative emissions thereafter, but what is the scale of CDR already needed in a 2035 and 2040 perspective?
  - What is the appropriate sequencing to enable the scaling up of CDR in time to achieve climate-neutrality? Which steps need to be taken by when to ensure that sufficient CDR-quantities are available by the required time?
  - How can the EU CDR governance be strengthened to deliver the required quantity of removals per year at optimal prices and minimal risks?
  - What would be the main purpose of such a CDR mechanism: to stabilise prices in the ETS, offset remaining emissions, achieve net negative emissions at the European level, finance the development and deployment of BECCS and DACCS, reduce peak temperature increases, …?
  - How can it be ensured that the scaling of CDR does not replace or distract from the need to achieve emission reductions?
  - Should there be one central CDR framework or several working in parallel? For example, could technical removals (i.e. DACCS and BECCS) in part be integrated into the ETS while having a separate mechanism directed at governments to govern the scaling up of temporary natural removals?
  - Should there be only one net emission target covering all emissions and removals without any further differentiation, or should there be differentiated emission and removal targets?
  - Should all CDR options be treated as equal or should there be a stronger differentiation by type of CDR, for example via technology specific CDR targets or dedicated policies and measures fostering specific promising but immature CDR technologies (e.g. DACCS)?
  - Should CDR be integrated into the ETS 1? If so, from which year (e.g. after 2035) and which CDR technologies should be eligible (e.g. BECCS/DACCS)? What additional support policies would be needed to enable the scaling up of CDR?
  - With regards to certification and liability, is it necessary to include an intermediary such as a European Carbon Central Bank between the ETS 1 and CDR projects or should CDR project developers be able to directly participate in the market? Will there be discount factors to achieve fungibility between different types of CDR units? Should different types of units be fungible?
  - How can the scaling of CDR be financed and what role can EU funds and instruments play?

1 Background

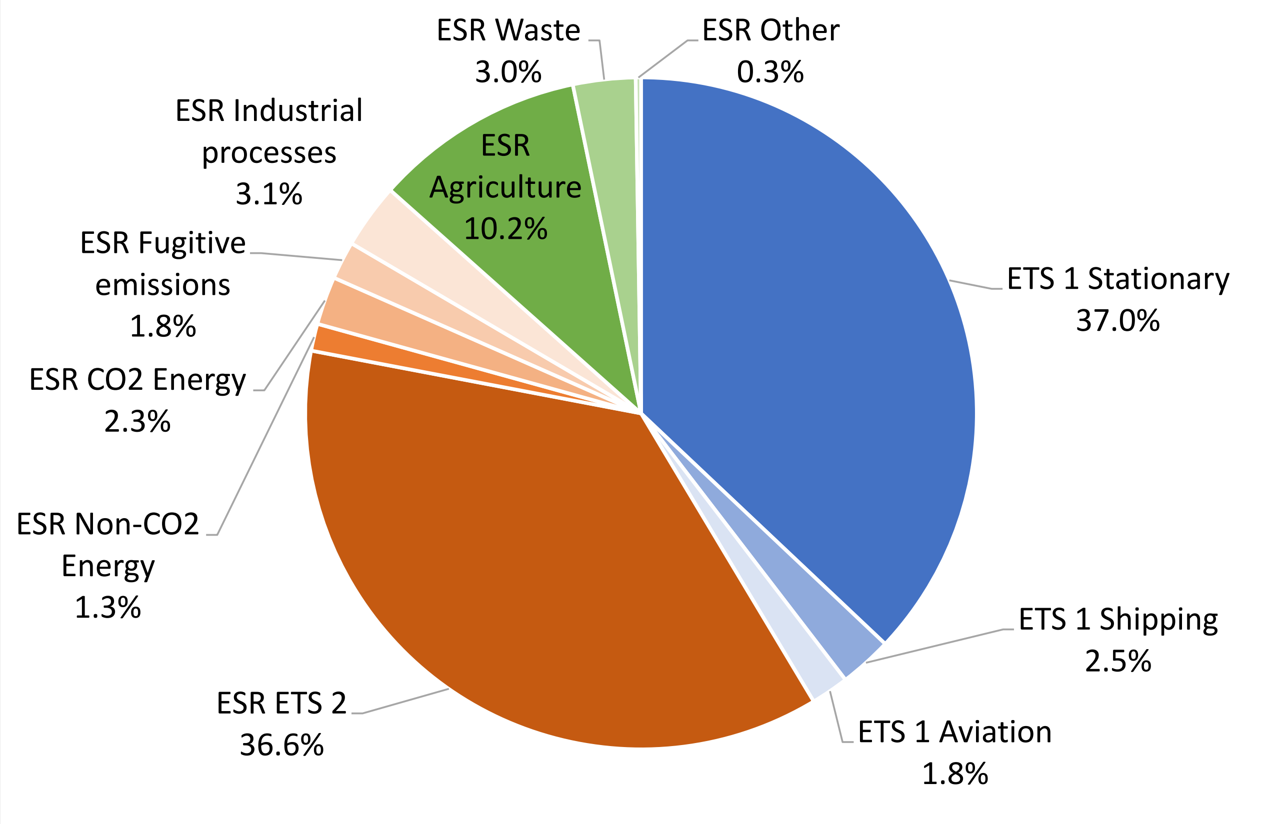
The European Climate Law, which was formally adopted in June 2021, enshrines the EU's goal of achieving climate neutrality by 2050 into legislation, as well as setting out an intermediary 2030 target of reducing greenhouse gas (GHG) emissions by at least 55%. The Climate Law also requires the European Commission to propose a 2040 climate target in 2024. The discussions for the 2040 EU climate target are closely linked to the Paris Agreement's five-year ambition cycle: All Parties to the Agreement are expected to initiate reflections on the next target in the context of the UN process in 2023, with a view to communicate these ahead of the COP 29 in 2025.

With the adoption of most of the Fit-for-55 policy package, the EU's climate policy is still based on three main pillars:

- The ETS 1 regulates emissions from large point sources as well as aviation; shipping will be included from 2024 onwards.
- The Effort Sharing Regulation sets national targets for most emissions outside of the ETS 1. In addition to raising these targets, the major update in the FF55 package was the introduction of a new ETS for transport, buildings and the remaining CO_2 emissions from fossil fuels in the energy and industry sectors.
- The LULUCF regulation gives the framework and targets for naturals carbon sequestration for Member States.

Currently, the ETS 1 for large stationary energy and industry installations is still the largest block of emissions covering 41.4 % of 2019 emissions (including aviation and the adopted extension to shipping) (Figure 1). The new ETS 2, set to start in 2027, is almost as large as the stationary ETS 1. Together, almost 80 % of current EU's total GHG emissions will be covered by an ETS within a few years. This share will decrease over the years because emissions from ETS sectors – mainly energy consumption – decrease much faster than from the remaining sectors. Especially agriculture, the largest sector outside of an ETS, has not achieved much in terms of emission reductions so far.

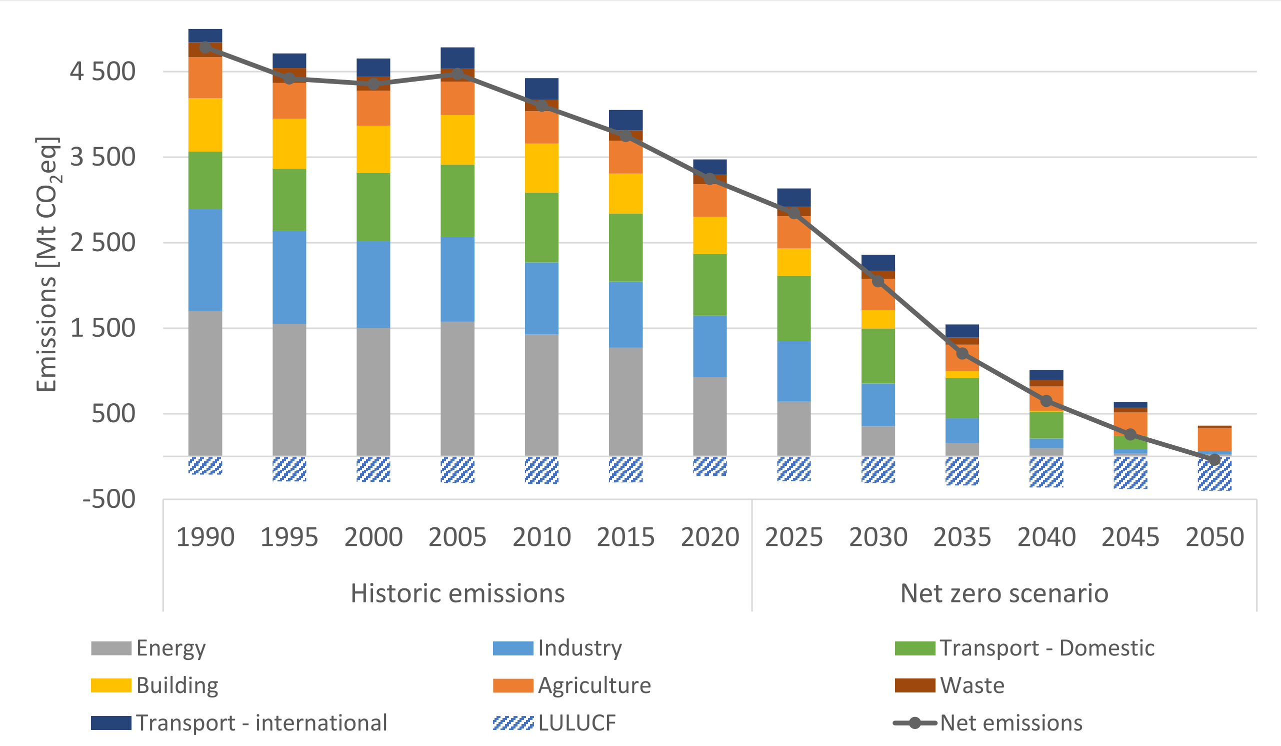
Figure 1: GHG emissions in the EU by instrument/sector in the year 2019



Notes: Emissions from LULUCF and international transport outside the EU ETS are not included.
Source: Öko-Institut with data from EEA (2023a), EEA (2023c) and EEA (2022).

Achieving climate neutrality by 2050 will require a steep increase of emission reduction rates for the next two and a half decades. Figure 2 shows the EU's emission development since 1990 until 2050 in a net zero scenario by sector. In this scenario by Graf et al. (2023), net emissions decline by 86 % between 1990 and 2040 (see also chapter 2.1). To achieve this, emissions from the buildings sector need to reduce by 98 %, from the energy sector by 95 % and from industry by 90 %. Emissions from the other sectors roughly need to be halved. The only exception is international transport with a reduction of 25 %. By 2050, remaining emissions are dominated by agriculture with small contributions from energy and industry installations and the waste sector. CO_2 removals from land-use activities need to increase by 70% until 2040 and reach a contribution close to double of the 1990 value.

Figure 2: Sectoral historic emissions and projected emissions in a net zero scenario



Source: Own graphic based upon Graf et al. (2023)

The aim of this paper is to identify and discuss the open questions that need to be resolved for setting a 2040 target and developing the comprehensive policy package to achieve such a target. To do so, it discusses the most relevant issues concerning the 2040 target in chapter 2 and the ETS 1 for stationary installations, aviation and shipping in chapter 3. Chapter 4 looks at the sectors covered by the Effort Sharing Regulation (ESR) with separate sub-chapters for the ETS 2, agriculture and the other remaining emissions covered by the ESR. Chapter 5 then looks at the treatment of negative emissions. Only in few places do we give a clear recommendation; the main purpose of this paper is to inform the upcoming debate but not to provide answers already. This paper does not look at the LULUCF sector.

2 2040 target and sectoral distribution

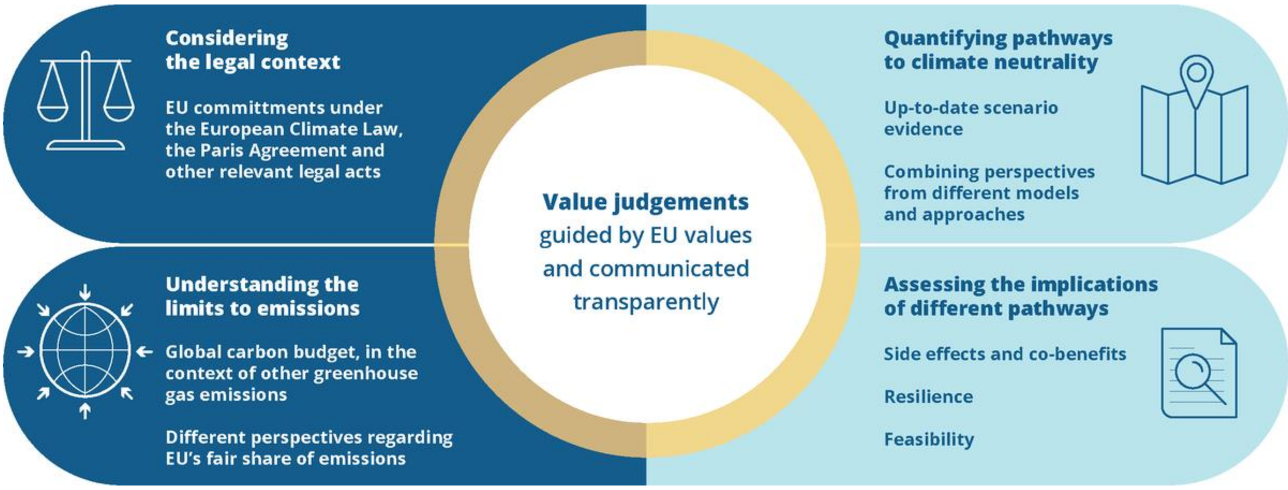
The level of the 2040 target compared to 1990 will be the one headline result in the EU climate policy debate with the highest public awareness; it will also determine the overall climate budget of the EU until 2050: with the agreement on the 2030 target and the goal of achieving climate neutrality by 2050, the entire pathway will be determined through the 2040 target. A recent study by Ecologic and Öko-Institut (Meyer-Ohlendorf et al. 2023b) compiled a series of reports and tools that look at the 2040 climate targets. The authors compile a list of reasons for setting an ambitious 2040 target:

1. Energy security and energy costs;
2. Dependence on critical raw materials;
3. Funding of authoritarian regimes and wars through fossil fuels;
4. Food security;
5. Migration due to climate change; and
6. Energy poverty and demographic change.

Different approaches can be used to set the GHG target. Common ones include calculating a fair share of the global carbon budget to achieve a set climate goal and bottom-up modelling. An approach based on the EU's fair share heavily depends on value judgements about how to distribute the remaining carbon budget, e.g. on historic responsibilities, population, or ability to pay. The results tend to lead to extremely high emission reduction obligations due to the high historic emissions of the EU's Member States. In its advice on the 2040 climate target, the European Scientific Advisory Board on Climate Change (ESABCC) calculated a remaining fair emission budget for the period 2020 to 2050 between 50 Gt CO_2eq and a deficit of almost -100 Gt CO_2eq (ESABCC 2023b). While relevant in a political and climate justice contexts, the fair share approach based on remaining budgets has only a limited ability to inform target setting. The other common approach – based upon bottom-up modelling – has been used in setting the 2020 and 2030 climate and energy targets of the EU. This approach looks at the target setting from the other side: which reductions are possible until a set date and how can these be achieved. Again, a large set of assumptions e.g. on adopted policies, innovation and acceptable levels of economic costs need to be taken. The achievable target level strongly depends on these assumptions.

In the end, the approaches to determine a climate target can only inform the political debate. The final target is a largely value based decision supported by scientific advice.

Figure 3: An evidence-based approach to setting scientifically sound EU climate targets guided by international legal commitments and EU values and principles.



Source: ESABCC (2023a)

2.1 Issues to resolve for 2040 target/architecture

Scope of the target

Article 2.1 of the European Climate Law (ECL) states: "Union-wide greenhouse gas emissions and removals regulated in Union law shall be balanced within the Union at the latest by 2050".

With the FF55 package, it is clear that net-net accounting will be used for the Land Use, Land Use Change and Forestry (LULUCF) sector. This means that only the difference between the net GHG flow from the LULUCF sector in a given year is compared with the value in the year 1990. For example, if LULUCF activities remove 10 Mt CO_2 in 1990 and 11 Mt CO_2 in 2030, 1 million tonnes of CO_2 removals can be claimed for 2030.

More open is the question of international transport. The initial NDC for 2030 with the target of a 40 % reduction included aviation in the scope of the EU ETS. Due to a lack of data on aviation emissions in that scope, it was finally agreed to include all fuel sales relating to international aviation both in 1990 and 2030 in the target estimate; by contrast, international navigation was excluded from the scope. The Council updated the EU NDC in October 2023 (CEU 2023): CO_2 emissions from aviation will now be included if they are subject to "effective carbon pricing". This is further explained as within the EU ETS but excluding those flights that are only addressed by CORSIA (see below). For shipping the scope is emissions of CO_2, CH4 and N2O navigation between EU ports. It is yet unclear, how emissions in this scope will be calculated for the year 1990. This scope is considerably smaller than the one in the climate neutrality target: It covers all emissions "regulated in Union law". The advantage of the 2050 target is, that it is not expressed against a historic reference year but as an absolute target (zero net emissions), i.e. it is not necessary to estimate emissions within the scope for the year 1990. Any estimate of emissions from aviation and shipping within the scope of the NDC or the EU ETS for 1990 will have very high uncertainties.

Yet, the scope is still open to interpretation:

- Shipping
  - Emissions from all activities covered by the EU ETS (see below) are clearly regulated by union law.
  - The MRV regulation for maritime transport (Regulation 2015/757) has a much broader scope. Regulated entities must report on their emissions; in theory, the ECL could be interpreted to also cover these emissions.
  - CH_4 and N_2O emissions from shipping will be included in the EU ETS and are regulated through FuelEU Maritime and therefore also clearly fall within the scope of the climate neutrality target. Possibly black carbon will also be included in the ETS in the future.
- Aviation:
  - Again, emissions included in the EU ETS are clearly regulated by Union law.
  - ICAOs Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is implemented through the ETS Regulation. The ETS will revert to the full scope, i.e. to all flights to and from the European Economic Area. For extra-EU flights on routes covered under CORSIA, EEA operators may use CORSIA units and only need to offset emissions above the historic reference value ("carbon-neutral growth"). Foreign operators are exempt (as they have to submit eligible units to their national authority) (see the fact sheet on aviation). This means that all emissions by EU carriers even if outside of the EU will be regulated by Union law.[1]
  - Non-CO_2 effects from aviation might be included in the ETS in the future. If so, this would increase the scope of emissions considerably (depending on the GWP used to calculate the impact of non-CO_2 emissions).

The 2040 target should ideally be in the scope of the climate neutrality target; if not, there is a danger that some emissions will not be addressed and would jeopardise the 2050 objective. At the same time, this leads to the problem that no historic emissions in that scope are available for the year 1990. There are different ways to deal with this:

1. Estimate 1990 levels in the ECL scope: The uncertainties of such an estimate would be relatively high but it would provide for consistent messaging. The Commission's Joint Research Centre published a consistent estimate of emissions from aviation and shipping in the ETS scope since 1990 which could be used for this approach (Mate Rozsai et al. 2024).
2. Use a different reference year for shipping and aviation: Any year from 2020 onwards would be usable for both shipping an aviation. The target for the other sectors would remain against 1990. Alternatively, the entire target could be expressed against 2020 or later; while consistent and in line with other countries, this would be a major break in the EU's climate messaging and might lead to (even more) confusion regarding the level of ambition.

[1] In 2026 the Commission will publish a report that assess the progress made in the implementation and strengthening of CORSIA. Depending on the assessment, the Commission will also propose revisions to the ETS Directive with regard to coverage to third countries (Graichen and Wissner 2023).

3. Express the 2040 target in absolute terms: Instead of expressing the target relative to 1990, it could also be expressed as a fixed quantity of emissions (XXX Mt CO_2eq incl. aviation and shipping). The drawback would be, that this quantity could not be compared to 1990 levels, i.e. it could not be expressed as an emission reduction as the main EU target.
4. Use fuel sales: Copying the approach used for the first NDC, it would be possible to use fuel sales for 1990 and the target year. While the simplest approach, it does have the problem that fuel sales for shipping are only loosely linked to activity.

From a methodological point, option 2 would be the most consistent with the ECL and using high quality data. Option 1 and 4 are easier to communicate. In absolute terms, shipping and aviation will contribute to a significant extent to total emission 2040 (see next section).

In the 2040 climate target plan (2040 CTP), the used scope for the modelling exercise is based upon the scope of the EU ETS (EC 2024). For both sectors all intra-EU activities are included; for shipping, 50 % of emissions from trips to/from the EU to third parties are included as well.

Key questions:

- What will be the scope of the target with regards to international transport emissions, including from a methodological standpoint?

Target level

Another fundamental decision for the 2040 climate target will be the setting of the overall target level. Meyer-Ohlendorf et al. (2023b) compiled different scenarios which are compatible with climate neutrality by 2050. Compared to 1990, the net reduction in these scenarios ranges between 86 % (European Commission 2020) and 97 % (Kalcher and Makaroff 2023). In June 2023, the ESABCC (2023b) also assessed a whole range of scenarios and, after excluding some due to high levels of environmental risks, recommended a range of 90 % - 95 % based on considerations of fairness and feasibility; the report also includes iconic pathways which would reduce emissions by 91 % until 2040.

The ESABCC also includes estimates for the impact of including international transport (CO_2 only). ESABCC estimate that the inclusion of all international transport would reduce the proposed 90 % to 95 % range to 88 % to 92 %. Further, Kalcher and Makaroff (2023) estimate that between 100 Mt CO_2 and 175 Mt CO_2 would be additionally included in the 2040 emissions. As a result, net emissions would be 87 % higher in 2040 in their 95 % target scenario, and 37 % higher in their 85 % target scenario due to the inclusion of international transport. The results by Graf et al. (2023) are within this range as well.

In the 2040 CTP, the Commission looked at three different target options (EC 2024): a net GHG reduction of 80% below 1990 (S1), of 85 % – 90 % (S2) and of 90 % – 95 % (S3). In the accompanying communication, the Commission recommended a net target of at least 90 %, which is approx. the average of scenarios S2 and S3.[2]

[2] In this report, we will call the 90 % scenario S2.5.

Key questions:

- What is the appropriate target level taking into account considerations of feasibility and fairness, as well as the potential inclusion of international transport?

Sectoral contributions and targets

Next to an overarching economy-wide climate target, policymakers may also want to develop binding or indicative sectoral emission reduction targets. The Effort Sharing Regulation, the ETS 1 and ETS 2 as well as the targets for LULUCF are existing separate targets addressing only a share of total emissions/removals. In addition to these climate targets, targets for energy efficiency and renewable energy amongst others form an integral part of the EU's climate governance. Many Member States have also set national targets for 2030 and/or climate neutrality.

Setting parallel and overlapping targets can lead to inefficiencies but might be necessary to achieve climate neutrality by 2050. For example, the decarbonisation of the building sector is a gradual process, limited by the number of houses which can be build and energetically renovated each year. If the emissions from this sector are only addressed as part of a national target, mitigation measures might focus on other sectors due to short-term opportunity costs. This would lead to a situation where it would not be possible to achieve climate neutrality within the remaining years until 2050. A target specifically addressing this sector would ensure that emissions would decline continuously. At the same time, sectoral targets might increase overall economic costs if they require more costly measures in some sectors while measures with lower costs in other sectors would achieve the same overall emission reduction.

National targets could also be a way to ensure that Member States governments take ownership and responsibility for their emissions and be an alternative for the Effort Sharing Regulation (see chapter 4.4).

Key questions:

- Should the EU include indicative or binding sector targets and where should be established (e.g. the Effort Sharing Regulation, the Governance Regulation, the EU Climate Law, the ETS Directive)?
- Given uncertainties about the individual sector contributions, how should they be established and defined? Should these sector targets be minimum contributions for each sector, or ensure target delivery?
- Should sector targets be aligned with the current ETS 1, ETS 2 and ESR framework? If not, how would this inconsistency be dealt with and what implications would it have for these instruments (e.g. the merging of ETS 1 and ETS 2)?

Role of carbon dioxide removals

Zero/low emission technologies and carbon dioxide removals (CDR) will play an increasing role in the EU's transition to climate-neutrality when looking towards 2050.[3] While there is no agreed definition of hard to abate emissions, it is very clear that there will be remaining emissions in 2050.

The revised 2030 target includes for the first time a carbon dioxide removal target of 310 Mt CO_2 in the land-use sectors. The recent Net Zero Industry Act Proposal of the European Commission also sets an EU objective to reach an annual 50 Mt injection capacity in strategic CO_2 storage sites in the EU by 2030, which could be used for negative emissions in the form of BECCS or DACCS.

Many different carbon management options exist with different key characteristics including permanence, costs and approach used. Debarre et al. (2019) developed a classification tree to group the different carbon management pathways (Figure 6):

- Natural CO_2 cycle: A natural process taking part without human intervention, e.g. the absorption of CO_2 in water and photosynthesis.
- Negative emission technologies which reduce CO_2 concentrations in the atmosphere
  - Natural process enhancers: All interventions in the biosphere intended to enhance the natural uptake, e.g. afforestation, ocean fertilization and enhanced weathering.
  - Engineered processes: All technological interventions reducing CO_2 concentrations, e.g. Bioenergy and CCS or direct air capture (DAC) and CCS.
- Zero/low emission technologies: Engineered processes that do not reduce atmospheric CO_2 levels but avoid an increase thereof. This includes fossil fuel combustion and CCS which is already allowed under the ETS 1.

In the 2040 scenarios above, all rely on CDR for the target level. Figure 4 shows the annual carbon removals in absolute terms in these scenarios, disaggregated between remaining emissions, natural and technical removals. Carbon removals range from 46 to 160 Mt CO_2eq per year for industrial removals and 317 to 413 Mt CO_2eq per year for natural sinks.

[3] Zero emission technologies are those that avoid the emission of additional CO_2 into the atmosphere, e.g. CCS for cement installations or the use of e-fuels in aviation. CDR refers to actual removals of CO_2 from the atmosphere, e.g. through afforestation or biomass combustion with CCS (BECCS). For an introduction into CDR see for example Gregor Erbach (2021).

Figure 4: Scenarios for GHG emissions and removals in 2040

Note: International bunkers are emissions from international aviation and maritime transport.
Source: Based upon Meyer-Ohlendorf et al. (2023b) with additional data from Graf et al. (2023) and EC (2024).

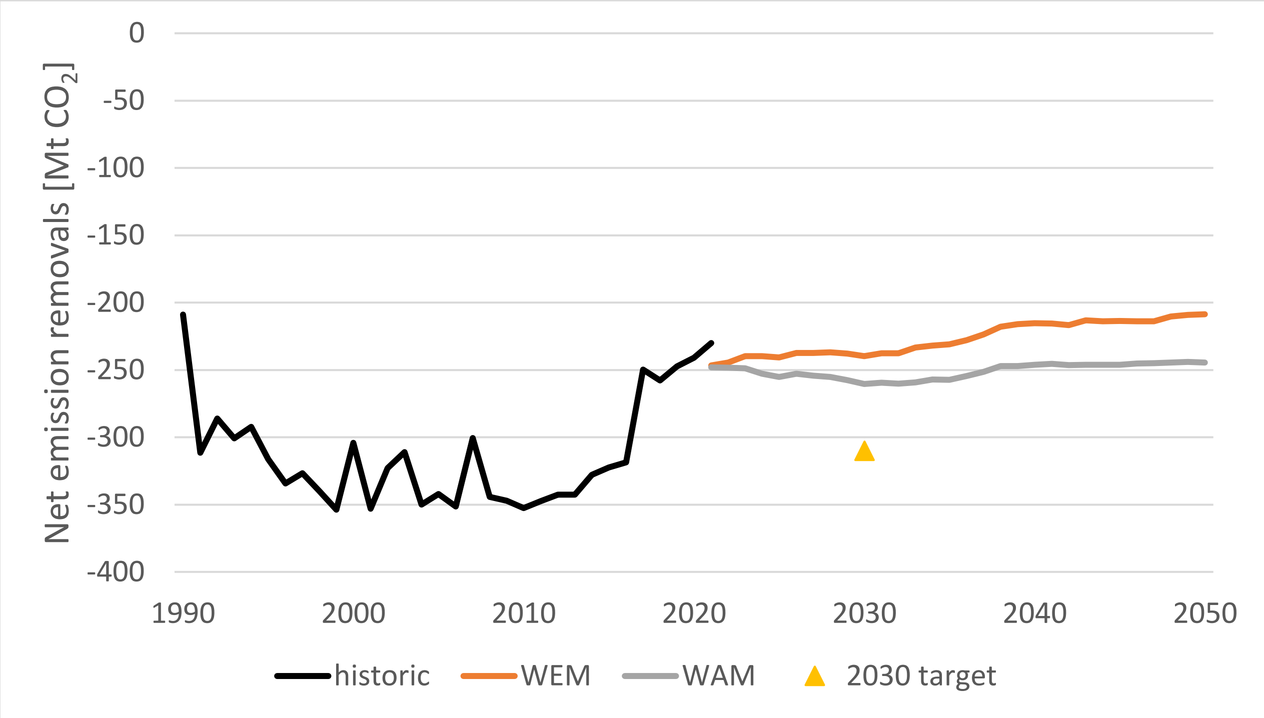
Absolute quantities and also the relative role of natural and technological CDR differ, but it is clear that all scenarios expect a much larger share of removals is expected from natural sinks than from industrial removals .

Achieving both the natural and technological CDR quantities will be a major challenge. Compared to historic rates the level of natural removals approximately doubles in some scenarios. The current trend is the opposite: Since 2010 the EU-wide trend has shown a strong decrease of removal quantities (Figure 5). In their own projections Member States only expect a stabilisation of current removal quantities both in the with existing measures (WEM) scenario and the with additional measures (WAM) scenario.

Technological CDR is still in its infancy, so only few installations exist. Large scale technological CDR will not only require investments in the facilities itself but also in CO_2 capture and transport infrastructure. In addition, local or national opposition to CDR projects might also negatively impact a large-scale rollout.

In this context of significant uncertainty around the potential to scale technical and natural sinks, an open question is whether there should be separate emission and CDR targets or only one net target including both emissions and removals. It could also be possible to set individual CDR targets by technology, e.g. to ensure that some CDR technologies enter the market despite higher costs due to other reasons such as permanence.

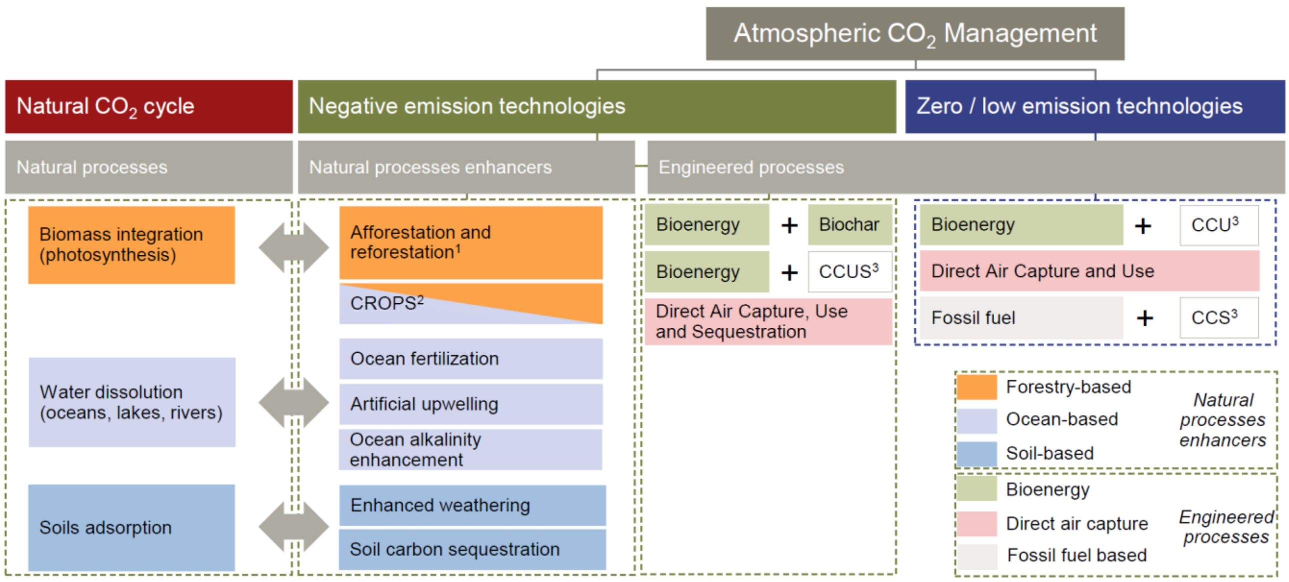
Figure 5: Net emission removals from LULUCF in the EU 27 compared to Member State projections and the EU 2030 LULUCF target



Source Own depiction using data from EEA (2023d)

Whether CCU – carbon capture and usage – can be qualified as a zero/low emission technology or even a negative emission technology also strongly depends on the source of carbon and on its use. Some products, e.g. e-fuels and plastic wrapping, have a very short life-time. Such cases should not be considered negative emissions or CDRf the CO_2 source was from the atmosphere this would qualify as a zero emission technology (e.g e-fuels). Other uses are expected to store carbon for a much longer time, especially wood used in construction could be seen as a medium-term storage option. It is crucial to clearly differentiate between the different carbon management options, treat them according to their specifics and set clear standards. A discussion of some policies and measures inside and outside of the ETS to foster CDR is given in chapter 5.

Figure 6: Carbon management classification tree



1. Planting trees is classified as negative for the timescale studied, even if it is not fully permanent.
2. CROPS is crop residue ocean permanent sequestration
3. CCS refers to carbon capture and storage, which is usually capturing waste CO_2 from point sources (power plant or factory) and storing it in geological formations; CCU refers to carbon capture and use; CCUS refers to carbon capture, use and sequestration; some of the uses release the carbon in the atmosphere (agriculture, beverage, etc.) making the process carbon neutral, and some store it (concrete, plastics, etc.) making the process carbon negative

Note: Other solutions such as wetland and coastal restoration (blue carbon) were not considered the study quoted for this figure.
Source: Debarre et al. (2019)

Key questions:

- Should the EU establish carbon dioxide removal (CDR) targets for 2040 or only one net target including both emissions and removals?
- Should a separate CDR target be differentiated by technology?

Role of international credits

The ECL clearly states that both the 2030 and 2050 targets are domestic targets, i.e. without the use of international credits under Art. 6 of the Paris Agreement. Despite this, there could be room for the use and potentially even setting an additional target for such credits to raise the ambition. They could serve as a mechanism for climate finance and go beyond the domestic target. This would reflect the historic responsibility of the EU's Member States and somewhat take into account the equity issues discussed under target setting.

The advantage of using Art. 6 outside of the EU's target is, that there could be less pressure to buy cheap units with limited to no benefit to the climate. This would especially be the case if the Art. 6 target would be formulated as a financing and not an emission quantity or if it would be limited to certain types of projects/sources of credits. Including international credits in the 2040 target would reduce the EU's climate ambition: Many of the projects that generate offset units use inflated baselines or very biased assumptions to calculate emission "reductions". Even in cases with higher integrity the quantification always requires a counterfactual baseline against which the project is measured. By definition, such baselines will always be uncertain compared to a domestic emission target which can be quantified with a high level of certainty. Lambert Schneider et al. (2023) found that projects that tend to have a higher additionality, i.e. actually reduce emissions, suffer from lower data quality and larger uncertainties when calculating emission reductions. Out of the 22 methodology they assessed, only one met their minimum standards for accuracy/ conservativeness. Half of the methodologies either overestimated emission reductions by up to 10 % or have an uncertainty of up to 50 %. Eleven methodologies overestimate reductions by at least 30 % or have uncertainties over 50 %. Calyx Global (2023) came to similar conclusions: Less than 10% of over 450 analysed projects received rating of A/A+, 16 % a rating of B/B+. The remaining 75 % were classified between C and E.

Buying credits from countries that overachieve their national target might be less problematic if these countries have set their targets with a sufficiently high ambition. However, doing so would set an incentive for potential sellers to have unambitious climate targets to be able to sell more “excess” emission reductions. Additionally, using a significant quantity of international credits in 2040 could also endanger the 2050 target. Remaining emissions would be higher and the 2050 target excludes credits by law. It is therefore paramount that no international units will be part of the EU’s greenhouse gas emission target in 2040 either.

Key questions:

- Should the EU establish a separate target for emissions reductions using international credits under Art. 6 of the Paris Agreement outside of the scope of the EU target to serve as a climate finance mechanism and raise climate ambition?
- How should linking with other ETS (e.g. Switzerland) be treated when determining the domestic target?

3 ETS 1

3.1 Introduction

The EU Emissions Trading Scheme (EU ETS 1) covers emissions from large point sources such as power plants and industrial installations[4], flights within the EEA and those departing to UK and Switzerland as well as – from 2024 onwards – maritime transport emissions. It regulates CO_2 emissions of all these activities as well as nitrous oxide emissions (N_2O) from the production of certain chemicals and perfluorocarbons (PFCs) from the production of aluminium. All EU Member States as well as Norway, Iceland and Liechtenstein participate in the EU ETS; the United Kingdom has ceased participation from 2021 onwards when it left the European Union.

Emission development in the EU ETS 1 is dominated by the emissions from power plants and industrial installations including oil refineries: in the third and fourth trading period the stationary installation sector caused 97% of the covered emissions, while the remaining emissions were from aviation.

Emissions in the stationary ETS have declined faster than in the other sectors of the economy: 2022 emissions are 38% below 2005 emissions (assuming the scope of the 4th trading period in 2005). The power sector has delivered the lion's share of the reduction.[5] Nevertheless two-thirds of current stationary ETS emissions are still caused by the power sector with coal/lignite plants emitting 65% of emissions of the power sector.

Industrial emissions have been rather stable, but in years of crisis the emissions are lower, reflecting lower economic activity (2009 values reflect the economic crisis and 2020 the COVID-19 pandemic). In several countries some industrial sector emissions remain below pre-crisis levels (e.g. cement in Spain), the longer-term effects of the COVID-19 pandemic. The effects of the attack on the Ukraine on the EU economy and energy-markets led temporarily to a sharp increase in natural gas prices resulting both in an increased coal use and a reduced demand for natural gas in certain sectors (e.g. as a feedstock in fertilizer production).

Aviation was included in 2012, originally covering also international flights but due to international political resistance the scope was reduced to cover flights in and between participating countries only. Since 2013 aviation caused on average 3 % of ETS 1 emissions. Whereas aviation activity increased year-on-year between 2013 and 2019, it dropped considerably in the years of the COVID-19 pandemic when travel restrictions were in force. In the last two years emissions have been on the rise again and especially international aviation emissions are expected to increase further as tourism returns to pre-pandemic trend levels.

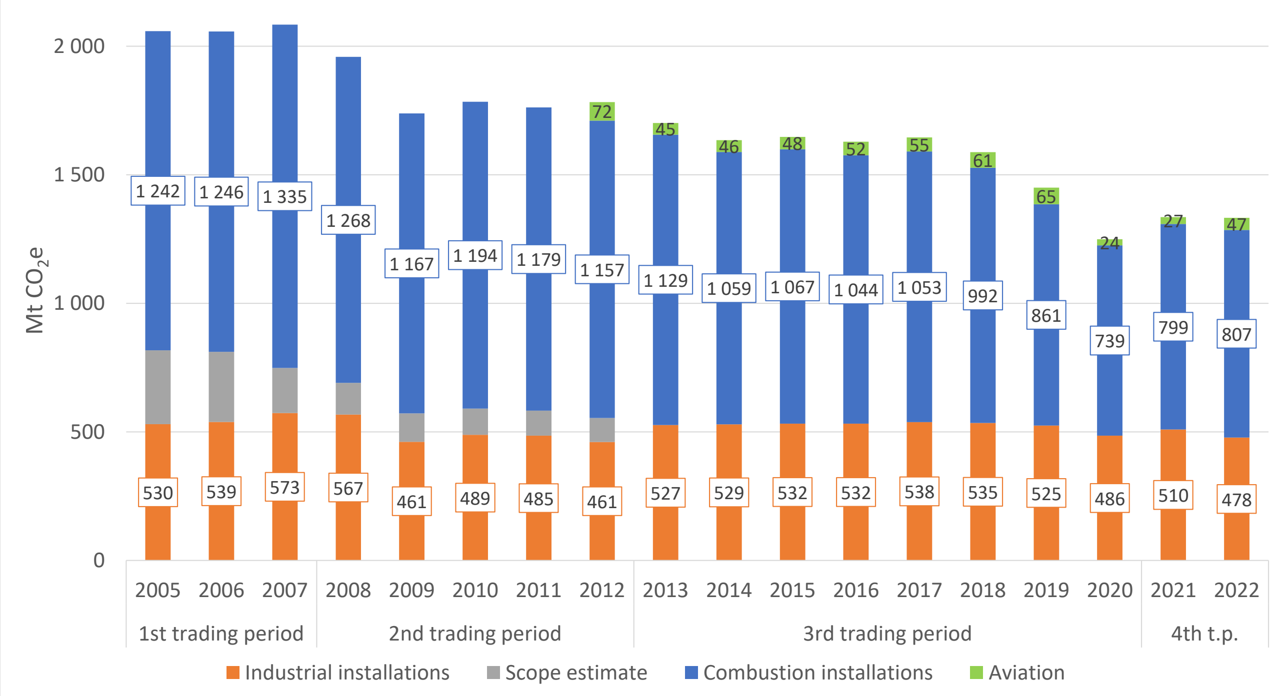
Maritime emissions will be covered from 2024 onwards and are thus not shown in the graph on historical developments. The covered emissions will increase by about 6 % due to the inclusion.6 For more information on aviation and maritime sectors see Wissner and Graichen (2024a) and Wissner and Graichen (2024b).

4 This includes electricity and heat generation, oil refineries, the production of iron and steel, aluminium, metals, cement, lime glass, ceramic, pulp, paper, cardboards acids and bulk organic chemicals above certain thresholds.

5 ETS activity 20 „Combustion installations“ include also industrial installations not covered by one of the industry sectors mentioned explicitly in the Annex of the EU ETS directive; their emissions are minor.

6 Estimate by Öko-Institut based on the Commission Decision on the quantity of ETS allowances in 2024 (EU 2023) for the share of maritime emissions in 2019.

Figure 7: EU27 Emissions covered by the EU ETS 1



Note: The grey scope estimate reflects installations/sources that were only included in the ETS at a later stage.
Source: Graph by Öko-Institut based on EEA EU ETS data viewer

3.2 Issues to resolve for 2040 target and policy architecture

With the Fit for 55 package (FF55) the EU ETS directive has been updated. The cap has been set more ambitiously and the market stability reserve (MSR) has been strengthened. The European Funds for Modernisation and Innovation are enlarged, and the Social Climate Fund introduced to which the ETS 1 will partially contribute. For certain sectors carbon leakage protection by means of free allocation will be gradually replaced by a CO_2 price for imports (the Carbon Border Adjustment Mechanism). Further adjustments concern the coverage of aviation by the EU ETS 1 and the inclusion of maritime emissions (CO_2 emissions to be phased in from 2024 onwards and additionally from 2026 onwards methane (CH_4) and nitrous oxide (N_2O) emissions). In addition, rules affecting the accounting for emissions avoided through capture and the long-term storage of CO_2 will be developed.

Further changes are possible and likely in the future as the EU Commission is required to review certain aspects (e.g. the inclusion of international aviation) and more generally monitor the development of the ETS directive to suggest further improvements. Important questions also arise in the context of the ‘ETS endgame’, as the cap on emissions approaches zero before 2040.

Coverage

The EU ETS directive foresees possible additional extensions in scope in:

- the transport sectors (aviation and maritime),
- the stationary sector (waste incineration and small installations), and
- the inclusion of negative emissions removed from the atmosphere.

The Commission will also prepare the inclusion of offshore ships starting in 2027 and assess covering smaller shipping vessels and additional pollutants in maritime transport, non-CO_2 emissions in the aviation sector and additional routes if ICAO fails to act. The introduction of non-CO_2 emission effects in aviation (and possibly black carbon emissions from maritime transport) would enlarge the coverage of the EU ETS 1 beyond the basket of Kyoto gases[7] and thus strengthen the overall EU climate ambition. For more information on the aviation and maritime sectors refer to the corresponding papers.

Waste incineration is currently exempted from both ETS schemes; so far, only Denmark and Sweden chose to unilaterally include those installations. There are around 390 waste-to-energy plants in the other countries participating in the EU ETS. In 2018 they emitted jointly 79 Mt of CO_2 out of which 43 Mt CO_2 can be attributed to fossil waste and the remaining 36 Mt CO_2 to organic waste (Warringa 2021). With the revision of the EU ETS directive in 2023 the Commission is required to provide a report by July 2026 to the European Parliament and to the Council assessing the feasibility of including municipal waste incineration installations into the EU ETS by 2028 while allowing Member States to opt-out until 2030 (Article 30 EU ETS directive). The Commission's report "should take into account the potential diversion of waste towards disposal by landfilling in the Union and waste exports to third countries" and consider the inclusion of other waste management processes, such as landfilling, fermentation, composting and mechanical-biological treatment (recital 98). Reasons for the inclusion are the need to strengthen incentives for a more "circular economy" for materials, to do more to reduce this significant source of emissions (recital 98). A study by CE Delft estimated that the inclusion of waste incineration would reduce emissions by 4-11 % CO_2 already by 2030 due to the increased economic incentive to reduce waste especially for companies and industries (Warringa 2021). The reduction can be increased significantly beyond 2030 if investments in waste sorting facilities and other enhanced recycling tecnologies increase – something a carbon pric should incentivise. Additionally, the study finds that employment is generated as recycling is more labour-intensive than incineration. The main condition for success in reducing emissions is that perverse incentives such as illegal dumping (increased exports) or landfilling are avoided. Thus a coordinated policy approach with other EU Waste legislation would be needed.

The Commission shall also assess the inclusion of smaller installations (below 20 MW total rated thermal input) and "how negative emissions resulting from greenhouse gases that are removed from the atmosphere and safely and permanently stored could be accounted for and how those negative emissions could be covered by emissions trading, if appropriate" (Article 30 EU ETS directive). The inclusion of smaller installations would take them out of the ETS 2; only if process emissions from small installations would also be included in the ETS 1 would the coverage of carbon pricing be extended. The potential advantage would be, that the ETS 1 has carbon leakage prevention mechanisms, something that is not included in the ETS 2. This issue of negative emissions is potentially also of relevance to balancing supply and demand as the cap declines – see below and chapter 5. However MRV and administrative compliance issues related to the inclusion of smaller installations would need to be examined.

[7] The Kyoto basket includes the following six greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and the F-gases (hydrofluorocarbons and perfluorocarbons) and sulphur hexafluoride (SF_6).

Key questions:

- Maritime transport: Should the coverage be expanded to include smaller shipping vessels and additional pollutants such as black carbon emissions?
- Aviation: Should the coverage be expanded to non-CO_2 emissions and additional international routes?
- Waste incineration: Should the coverage be expanded to include municipal waste incineration installations?
- Smaller installations: Should smaller installations (below 20 MW total rated thermal input) be included in the ETS 1 - taking them out of the ETS 2? What MRV and administrative compliance issues would need to be considered?
- Negative emissions: Should negative emissions be covered by emissions trading?

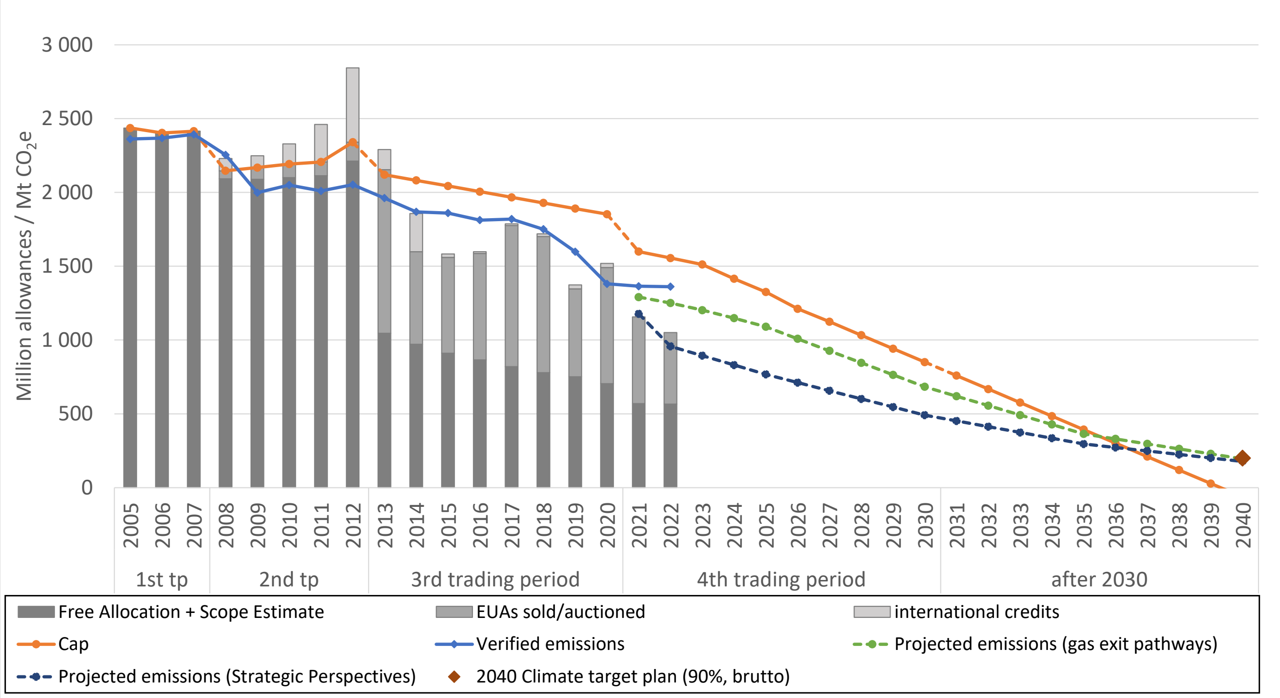
Overall ambition: Cap decline and inclusion of negative emissions

The cap sets the ambition level of the scheme as it defines the maximum allowable amount of emissions. In the first and second trading period the cap was set too high: business as usual emissions were lower than the cap leading to low carbon prices and a huge surplus of allowances in the scheme. Allowing international credits into the EU ETS further contributed to the surplus. As a reaction the use of Kyoto offset credits was prohibited, the EU ETS cap was reduced and measures for allowance quantity control - such as backloading and the market stability reserve (MSR) - were introduced.

The pace the cap is declining at is set by the linear reduction factor (LRF). From 2024 onwards the cap will be reduced by 4.3 % per year and from 2028 onwards by 4.4 %. The LRF has no end date and, if left unamended during future ETS revisions, would lead to a cap of near to zero emissions in 2039 (see graph below). This raises a question about the feasibility of achieving zero gross emissions from stationary installations in the ETS 1 by 2040. Of course, it would be impossible – and unwise for the sound functioning of the market – to change the already agreed LRF before 2030. This would also throw EU climate targets into question and undermine investment certainty. However, the LRF has been re-evaluated during the ETS revision twice already, and such a re-evaluation can also be expected for the period after 2030 as well.

Typically, analysis of the technical abatement potentials of both the power sector and industrial sectors have indicated that some small fraction of residual emissions may remain in a net zero economy. For instance, even in very ambitious decarbonisation scenarios, such as in the Agora EU Gas Exit Pathway or the 90% scenario from Strategic Perspectives, some emissions remain in the stationary sector and even more in aviation as the availability of sustainable biofuels and e-kerosene is limited (see Figure 8).

Figure 8: Cap, verified emissions and supply of allowances in the EU ETS 1



Source: Öko-Institut MSR model, projected emissions based on Graf et al. (2023), the 90 % scenario from Kalcher and Makaroff (2023) and EC (2024).

The system as it currently stands is not designed for a cap of no emissions unless all ETS 1-emissions can be abated or captured and permanently stored. To date the ETS does not include negative emissions, only zero emissions in the case of CCS with 100 % abatement or if biomass/biofuels are used for combustion that comply with the sustainability and greenhouse gas emission-saving criteria established by Directive (EU) 2018/2001. Due to technical obstacles, it is also not realistic to assume that all emissions in the ETS can be avoided, captured and stored or used. Even today's best available technologies such as producing "green steel" using hydrogen might still have residual emissions, as will installations using CO_2 capture processes as the capture rate is likely to be less than 100 % in most instances. Furthermore, complete decarbonisation requires substantial infrastructure investments and further development of emissions free energy carriers; these can face substantial bottlenecks due to permitting, etc.

Before adjusting the ETS or its LRF, a first best approach to this question is to redouble efforts on complementary policies to the EU ETS. There is likely to be a world of difference between an EU industry with strong support for low-carbon energy infrastructure, de-risking instruments for rapid investment in breakthrough technologies, and strong lead markets for green materials, and an EU industry facing a strong carbon price without these supporting policies or funding.

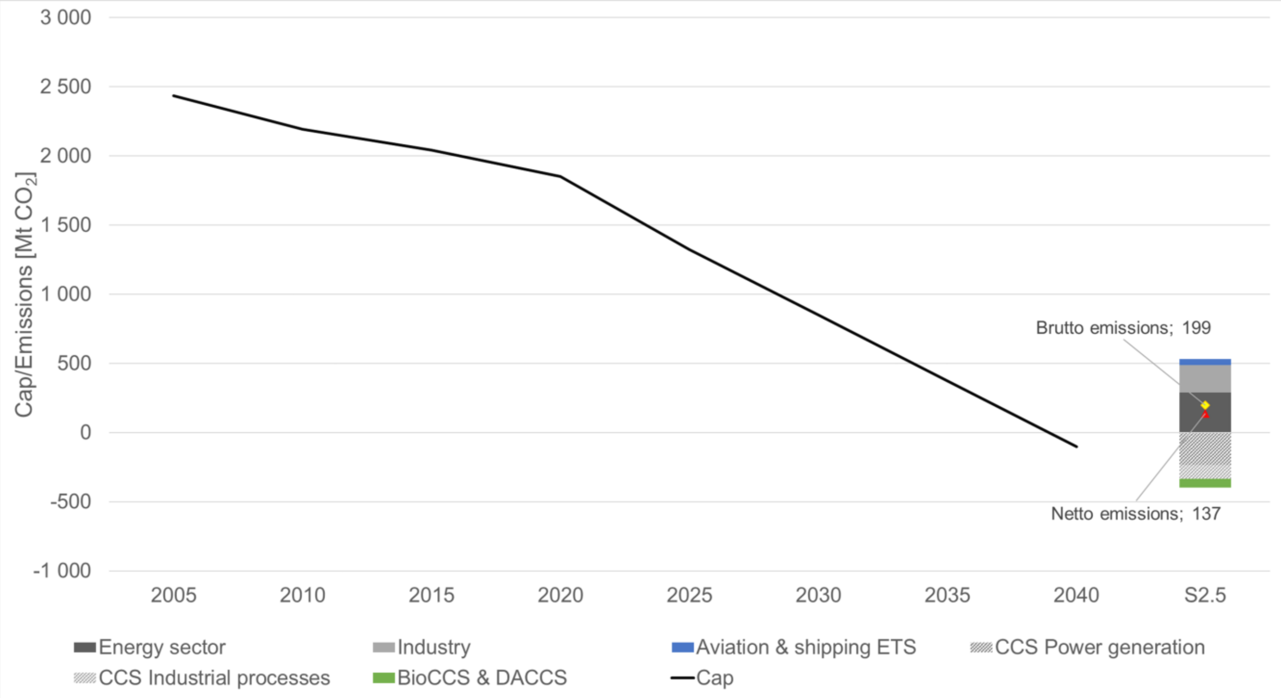
Nevertheless, it is also worth considering possible scenarios for the future of the LRF, or equivalent policy ideas. These include:

- modifying the rate of the LRF from its current rate and/or stabilising the long-term allowance supply at a level above zero,
- leaving the LRF as it is and including – either directly or indirectly –negative emissions into the scheme, and/or
- the merging of ETS 1 and ETS 2 as an option to include further activities.

The merging of ETS 1 and ETS 2 is discussed in chapter 4.1.2. and thus not re-discussed here. It has to be noted that this option would only increase supply for a few years and not address the fundamental question.

Based on the 2040 CTP, a combination of both will be required (Figure 9). By 2040, gross emissions from ETS 1 are still projected at 200 Mt CO_2eq in the scenario S2.5. Gross emissions are already after fossil CCS, emission generation is 333 Mt CO_2eq. Industrial removals – i.e. _BioCCS and DACCS, are estimated at 62 Mt CO_2 in 2040, i.e. if included in the ETS 1 net emissions would still remain at approx. 135 Mt CO_2eq. Even in the most ambition scenario S3 net emissions would still be around 80 Mt CO_2eq (Graichen forthcoming). The implication of this is clear: either the LRF needs to be changed or CDR beyond industrial removals (i.e. BioCCS and DACCS) would need to be integrated into the ETS 1.

Figure 9: Historic cap development, current legislation and 2040 emissions from ETS 1 in the S2.5 scenario



Source: Graichen (forthcoming)

Concerning the first two options, there are arguments for and against each of these options, although some options are less desirable on balance than others. Keeping the LRF as it is would continue the current ETS rules and provide a clear pathway towards carbon neutrality in the ETS. This could most likely only be achieved by allowing both industrial as well as natural CDR into the ETS; none of the 90 % emission reduction scenarios project industrial CDR alone to be able to offset 200 Mt CO_2 in 2040. Natural CDR suffers from much higher uncertainties with regard to removal quantities as well as storage duration. A direct inclusion would seriously undermine the ETS but there are proposals how this might be done by using intermediaries guaranteeing the removal (see discussion in chapter 5). In this approach, operators in the ETS 1 would directly finance the costs for carbon removals.

If the LRF is modified it would not be necessary to include natural CDR in the ETS 1. It would not be necessary to try to develop a scheme that tries to create equivalence between avoided emissions, permanent removals through industrial CDR and uncertain and short-term natural CDR. In such an approach, there would remain auctioning revenues in 2040 and beyond which could be used to finance CDR. The last coal power plants will likely be decommissioned during the period until 2035; having to separate LRF – one until 2035 and one afterwards – could reflect this and ensure that no new short-term oversupply of allowances is created.

Negative emissions can be achieved in several ways: by capturing and storing emissions from installations using sustainable biomass (BECCS), by removing emissions from the air and store them (direct air capture – DACCS) or by enhancing natural processes (cf. chapter 5).

To preserve the environmental integrity of the EU ETS, the allowable negative emissions would need to be measurable with a high degree of accuracy and the permanence would need to be very long. Including BioCCS into the scheme could build on existing monitoring and reporting rules in the EU ETS for industrial installations and for CCS as well as the requirements for sustainable biomass. Including DACCS would mean that installations with no (or nearly no) emissions are to be included into the scheme, which goes along with the work to include other non-emitting facilities such as hydrogen electrolysers. As mentioned above, nature-based solutions such as afforestation or different agricultural practices are associated with higher uncertainties both with regards to measuring the CO_2 removal as well as the permanence of it. Therefore, this option does not seem recommendable in the framework of the EU ETS.

While the price on carbon will help funding/the business case for such removals, it remains uncertain – and frankly unlikely in many cases – that the carbon price would suffice to make them economically viable. Today the EU already uses or allows member states a wide range of financial de-risking options and complementary policies for simple emissions reduction projects in ETS sectors (e.g. feed-in tariffs or premia, (carbon) contracts for difference, capex funding via the Innovation Fund, etc). For scaling capex intensive and high-risk negative emissions projects, additional funds and a range of regulations, local infrastructure planning, etc, would be required.

It also remains unclear whether a permanent removals market can be funded reliably by a declining number of emitting installations under the ETS 1 and whether supply and demand would balance. The prospect of a declining set of residual emissions (demand side) compared to the need for a massive growth of removals (supply side) raises concerns about market equilibrium and thus also the robustness of business cases for large and long-lived projects. Some intermediary (like the MSR or Innovation Fund-like instrument) would likely be required if negative emissions were to enter the ETS1. This raises other hybrid options to explore, such as indirect inclusion of negative emissions into the ETS1 via the MSR, “a removals fund/pool” or similar instruments. In general, it needs to be ensured that incentives for mitigation options under the ETS 1 are not watered down. Mitigation needs to prioritized as carbon removal technologies still only exist at a pilot project stage and many uncertainties regarding cost, energy consumption and storage sites exist.

If BioCCS and/or DACCS are included into the EU ETS, operators would have to report on their emissions and removals and receive certificates for the removed quantity. Those certificates could be used by themselves or sold to other EU ETS participants.

Key questions:

- How can the “ETS endgame” – the period where the supply of emissions allowances approaches zero – be managed given the difficulties of reducing emissions and thus the continued existence of residual emissions falling under the ETS 1?
- What complementary policies are needed to help scale up negative emissions project and minimize or even eliminate the gap between the ETS cap and residual emissions in 2040?
- After complementary policies have been strengthened to the maximum extent, Should the rate of the rate of the cap decline be adjusted from 2035 and/or the long-term allowance supply be stabilised at a level above zero?
- Should negative emissions be directly or indirectly included in the ETS 1? If indirect inclusion is chosen, which institution would serve as intermediary between the ETS 1 and the negative emissions projects (e.g. the MSR or a European Carbon Central Bank)?

The Market Stability Reserve

At the beginning of the third trading period the carbon market was characterized by a huge surplus of allowances and carbon prices of below 10 Euro per ton of CO_2e; these price levels did not suffice to trigger significant emission reductions. The quantity control measures introduced included a short term intervention dubbed backloading – the auctioning of 900 million allowances was postponed.[8] It was supplemented in 2019 by the market stability reserve which works continuously to ensure the right balance of liquidity in the market – too much liquidity has been found to excessively depress short time carbon prices (Schopp and Neuhoff 2013), while a certain amount of forward hedging liquidity is necessary especially for those participants not receiving free allocation and selling forward contracts for their goods such as electricity providers. Determining the optimal liquidity for calibrating the MSR has always been a challenging question for the ETS. Before its introduction hedging demand was estimated focussing on electricity providers and the thresholds activating the MSR mechanism set accordingly: When the number of allowances in circulation (i.e. the surplus) surpasses a certain level (833 Mio. EUAs), the auctioning amounts are reduced and the unauctioned allowances placed in the MSR. So far, this has been the case every year since the introduction of the MSR. If the number of allowances falls below a second threshold (400 Mio. EUAs), allowances from the reserve are added to the auctioning amounts and thus the liquidity in the market is increased. To remove any structural over-supply of allowances, any quantities in the MSR beyond 400 Mio. EUA are invalidated and cannot be returned to the market.

While emissions have declined, the MSR thresholds have essentially remained unchanged. However, since emissions have declined – especially for electricity generation – and free allocation will be replaced by CBAM, this has had and will have an impact on the hedging demands of ETS market participants (in combination with the volumes of the forward contracts).

If emissions decline further and the MSR thresholds remain unchanged, the MSR would stop taking in allowances, while the liquidity in the market would be very high compared to yearly emissions. This could have the effect of making prices crash.

8 The planed auctioning amounts were reduced by 400 million allowances in 2014, 300 million in 2015 and 200 million in 2016. These allowances were later placed in the market stability reserve.

As the ETS ambition becomes harder to meet, uncertainty about ETS prices arguably increases. This can lead to price volatility both to the upside or downside. Therefore, it should be considered to update the estimate of the hedging demand regularly to reflect the changing realities of the market. These adjustments should also consider the decline of free allocation for industrial sectors covered by the Carbon Border Adjustment Mechanism. Alternatively, the thresholds could decline in line with the cap as a proxy for emission developments.

It might also be necessary to design a novel market stability approach for the ETS endgame situation. If the LRF is changed and a cap well above 2040 remains, the MSR could remain but with updated parameters. With a cap that is close to zero, the current approach might not be suitable anymore as there is no supply which can be balanced with demand. The governance of CDR – which could be integrated into the MSR in some way – will require novel approaches and a complete overhaul of the current MSR.

In the ETS 2, the MSR can also be triggered by the CO_2 price development. Currently, it only reacts if prices exceed a threshold or rise very fast. There could also be a case to add a price floor into the MSR: while it seems unlikely that low CO_2 prices will be an issue, a price floor gives certainty for economic assessments and access to finance.

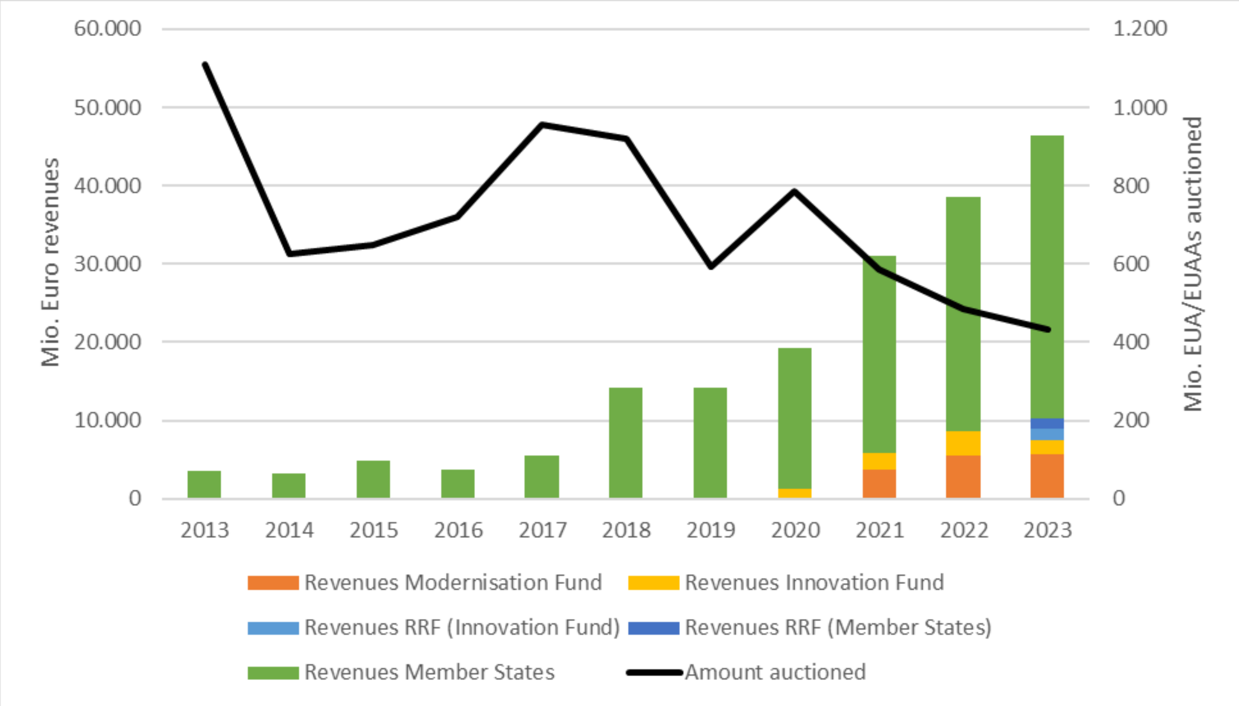
Key questions:

- Does the MSR need to be reformed for the period after 2030 to avoid volatility in the ETS market on either the upside, the downside or both?
- Is the current MSR design fit for net-zero? What alternative design would be more suited for the ETS end-game?
- Should the MSR thresholds be updated regularly to reflect the changing realities of the market and the accelerated decline of free allocation for sectors covered by the CBAM?
- Should there be a price floor to provide certainty for investments?

Auction quantities

Auctioning of allowances has become more and more important in the EU ETS and the revenues generated have played an important role in securing support for climate policy and funding transition. While the auctioning amounts have been declining since 2020, revenues have increased as the carbon price rose generating revenues of over 40 billion Euros in 2023 (see Figure 10).

Figure 10 Auctioning amounts and revenues 2013-2023



Source: Öko-Institut with data from EEX (2023)

In the first two trading periods most allowances were handed out for free. Since 2013 auctioning is the predominant method of allocation. Auctioning shares differ between the different sectors covered:

- In the aviation sector the auctioning share of 15 % increases to 36,3 % in 2024, 57,5 % in 2025 and all allowances are auctioned from 2026 onwards.
- In the maritime sector all allowances are auctioned from the start in 2024.
- In the stationary sector 57 % of the total number of allowances available is to be auctioned in the period 2021-2030. However, 3 % of the available allowances will be kept as a buffer for free allocation, which could reduce the auction share to 54 %. This is intended to prevent an across-the-board reduction in free allocation for all installations through a cross-sectoral reduction factor. This reduction factor guarantees that the total amount of free allocation does not exceed the envisaged cap share. At the same time the carbon border adjustment mechanism will decrease free allocation; allowances not needed for free allocation are to be channelled to the innovation fund.

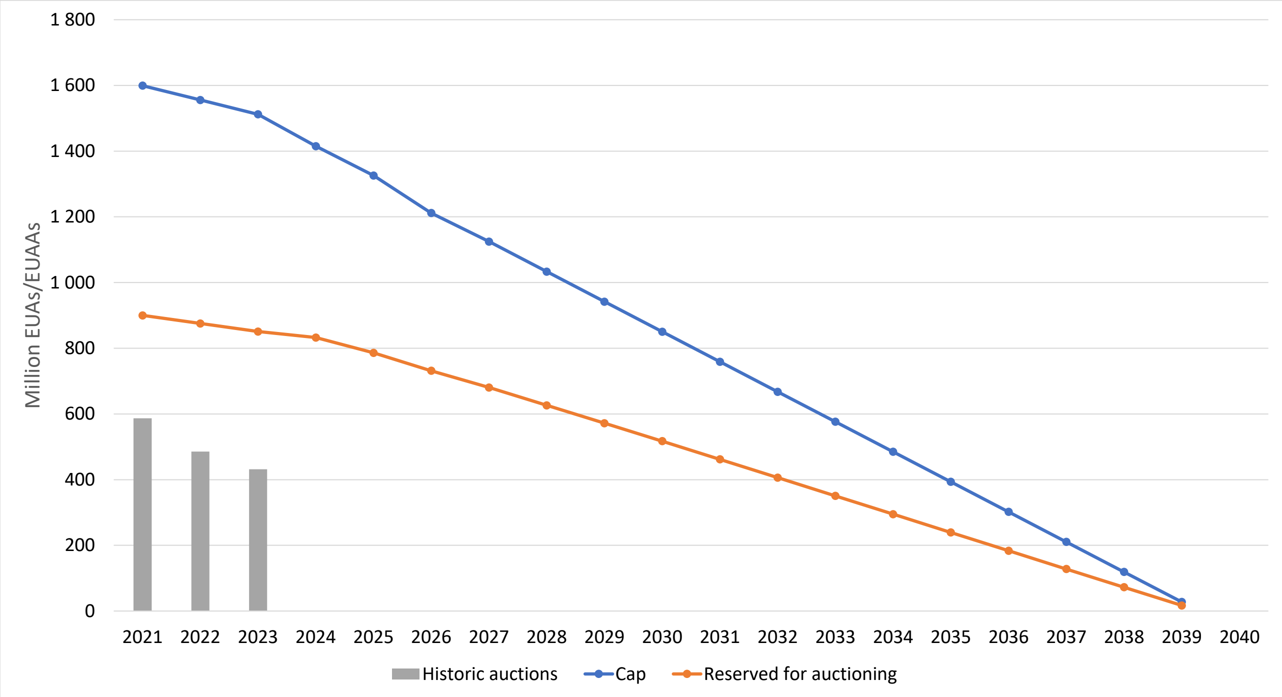
More broadly, the future amount for auctioning depends on three key determining factors:

1. the future cap development;
2. the influence of the market stability reserve; and
3. the amount reserved for free allocation.

The future cap depends on the future linear reduction factor and potential additions in scope. Figure 11 shows the development of the cap over time assuming all parameters remain unchanged. Assuming that the full share of the cap designed for auctioning, nearly 3 000 Mio. EUAs are still to be sold in the period 2026-2030 and another 2 000 Mio. EUAs in the decade up to 2040.

Currently the auctioning share is lower, though, as the MSR is active. The market stability reserve may reduce or increase the amount for auctioning depending on the liquidity of the market. If emissions continue to stay below the cap in the next years, the MSR will absorb a share of the amount reserved for auctioning. In the years 2019-2023, 32 % of the cap were auctioned and the difference to the allowed amount for auctioning fed into the MSR. If the market becomes tight, allowances from the MSR will be released and added to the auctioning amounts. Due to the invalidation mechanism in the MSR, the quantity of released amounts is much lower than the intake.

Figure 11 EU ETS 1 Auctioning amounts 2021-2040



Source: Own calculation based on Directive 2003/87/EC (2003) with data from EEX (2023)

Reducing the amount dedicated to free allocation would free up additional amounts for auctioning. Free allocation is declining over time as the benchmark values get more stringent to reflect the improvement in carbon intensity. Furthermore, the carbon border adjustment will gradually replace free allocation for some sectors as carbon leakage protection measure over time. The allowances freed up will be fed into the innovation fund. Currently, CBAM sectors receive almost half of the allowances handed out for free. Starting in 2026 the CBAM is phased-in and the free allocation of covered sectors reduced accordingly. A rough estimation by Öko-Institut finds that total free allocation would be reduced by 1 % compared to a scenario without the CBAM in 2026, rising to 10 % in 2029 and 20 % in 2030. When the CBAM is fully phased-in for the sectors currently covered, free allocation would be reduced by half. If the CBAM is extended to cover embedded emissions stemming from electricity consumption, it can also reduce the need for indirect compensation, i.e. financial support for electricity intensive industries situated in the EU.

Key questions:

- Should free allocation be reduced further to free up additional amounts for auctioning, e.g. through the inclusion of additional products into the CBAM and a phase-down of free allocation for these emissions?
- Should the mechanism for invalidating allowances under the MSR be changed to reduce the difference between the allowances released and the allowances taken in by the MSR?

Revenues and EU ETS funds

Auctioning proceeds feed three funds at EU level and Member States are required to use auctioning revenues to reduce GHG emissions and to adapt to the impacts of climate change both domestically and supporting international funds/initiatives (Articles 10, 10a, 10d EU ETS directive). Also, the administrative cost of the EU ETS 1 as well as indirect compensation to industries with high carbon cost embedded in electricity may be covered. Before the ETS reform in 2023, Member States were required to spend at least 50% of their auction revenues for climate- and energy-related purposes. Member States reported to have spent 76% of their revenues accordingly (EC 2022b). In the future, 100 % of the proceeds shall be spent on these purposes, as well as the support of household with lower income.

The EU funds play an important role to help accelerate the decarbonization of industries, to help building political support and to reduce the impacts of carbon pricing on poor households. The funds are:

- The ‘Modernisation Fund’ targeted at Member States with comparatively low per capita income for the modernisation of their energy supply.
- The ‘Innovation Fund’ to support innovation in low- and zero-carbon techniques, processes and technologies that contribute significantly to the decarbonisation of the sectors covered by the EU ETS Directive and contribute to zero pollution and circularity objectives.
- The ‘Social Climate Fund’ to provide financial support to Member States to implement their Social Climate Plans for investments to promote the reduction of fossil fuels dependence. The Plans can also include temporary direct income support.

The auctioning amounts of the funds are not impacted by the market stability reserve; only the amounts auctioned on behalf of Member States are reduced when the MSR is active. In the years 2021-2023, Member States received together about 80% of the auctioning revenues while the remaining 20% fed EU funds (see Figure 10). With the Fit For 55 package EU funds have been strengthened: The Modernisation Fund is funded by auctioning 4.5 % of the cap from 2024 onwards – an increase compared to the 2 % auctioned till 2023. Member States may also decide to transfer additional revenues from the auctioning of EU ETS allowances to the Modernisation Fund, leading to a total possible amount of 643 million allowances in the period 2021-2030 (EC and EIB 2023).

The overall size of the Innovation Fund has also been increased in 2023 from 450 mn allowances to approximately 530 mn allowances in the period till 2030 (DG CLIMA 2024). It is set to increase further at the inclusion of additional activities and the reduction of free allocation due to the CBAM. In addition, 50 mn allowances from the ETS 1 are auctioned on behalf of the Social Climate Fund (see chapter 4.1.2).

In light of the Russian attack on Ukraine the European Parliament and the Council agreed to finance additional actions under REPowerEU in the Recovery and Resilience facility (DG CLIMA 2023). Over a period of four years (2023 to 2026), enough allowances are to be auctioned to mobilise a revenue volume of EUR 20 billion. 40 % of these allowances will be taken from the quantities auctioned by the member states in the period from 1 January 2027 to 31 December 2030. The remaining allowances, 60 % of the total volume, will be taken from the Innovation Fund.

With the declining cap, several measures can be taken to secure financial support for decarbonisation:

- Stricter rules for the use of proceeds;
- Adjusting the share of the cap assigned to free allocation downwards;
- Use of income from the CBAM.

The rules for the allowed purposes to spend the proceeds from auctioning have been tightened but still include allowable spending which does not necessarily leads to decarbonisation. For example, the financial support for electricity-intensive firms for the carbon-cost included in electricity prices (indirect compensation) serves mainly the purpose to protect international competitiveness of those firms while reducing the incentive to invest in energy efficiency. Likewise, under REPowerEU not only energy savings and acceleration of the rollout of renewables can be supported, but also the diversification of energy supplies e.g. via stepping up LNG imports and higher pipeline gas deliveries to reduce dependence on Russian fossil fuels (DG COMM 18 May 2022).

The share of allowances for auctioning can be increased if less allowances are allocated for free. Another option is to use CBAM proceeds on top.

With the introduction of the CBAM, importers will have to buy CBAM certificates to pay for the embedded emissions of certain imported goods (see below). These revenues will need to support the administrative costs of the CBAM, but a part of them - or equivalent amounts - should arguably be returned to international climate finance facilities to the benefit of Least Developed Countries, in order to secure global acceptance for the mechanism while also honouring the EU's international climate commitments under the Paris Agreement. Indeed, international climate finance remains one of the key sticking points in the international negotiations. Further and more creative thought on how the EU can help to resolve this blockage, potentially by leveraging at least a part of its ETS revenues or other climate fees is needed.

More broadly, climate and other strategic priorities of the EU are going to become more and more important as sources of pressure on the EU budget. Budget priorities related to the transition of ETS sectors such as strategic technology value chains, critical raw materials production, developing strategic decarbonisation infrastructure, financing building retrofits, climate change adaptation, keeping electricity prices under control for consumers and strategic industries and supporting carbon contracts for difference for industrial decarbonisation will become more relevant. How the EU will afford and optimise spending across these various strategic priorities is a major challenge of the next EU budgetary cycle.

Such issues go beyond the capacity of the EU ETS to resolve, although it will almost certainly (continue) to be required to contribute. There is therefore a risk that the EU ETS funding streams are 'watered down' to the point where, rather than achieving one or two goals effectively, they support many objectives ineffectively. Seen in this broader context, a strategic review and possible restructuring of the way the EU funds the climate transition, and the way existing fiscal and monetary tools could better support the transition, seems necessary.

Key questions:

- Should the EU set more restrictive rules for the use of ETS revenues to ensure they are used for purposes that primarily and directly support decarbonisation?
- Should part of the revenues from the CBAM be returned to international climate finance facilities to the benefit of Least Developed Countries, in order to secure global acceptance for the mechanism while also honouring the EU's international climate commitments under the Paris Agreement?
- How can the EU and member states optimise the spending of ETS revenues across various strategic priorities? Put differently, given current budget constraints and large demands for ETS revenues, how can it be avoided that ETS revenues are spread thinly and support many objectives ineffectively, rather than achieving one or two goals effectively?

Carbon Leakage protection for industries, free allocation, and carbon border adjustment

Carbon leakage occurs if EU climate policy drives EU production (with the associated emissions) to relocate to countries with less stringent climate mitigation efforts. Industries deemed at risk of carbon leakage receive free allocation based on benchmarks to prevent this. With a declining cap the number of allowances that can be allocated for free is shrinking, too. With the FF55 package it was decided to establish a carbon border adjustment mechanism (CBAM) for selected products. The mechanism is envisaged to replace free allocation and eventually the compensation for indirect emissions for included sectors.

The CBAM covers imports of electricity and basic materials as well as basic material products in the following sectors: iron and steel, cement, aluminium, fertilizers, and hydrogen. It mirrors the scope of the EU ETS and covers the same gases. For all sectors direct embedded emissions are covered, i.e. emissions stemming from the combustion of fuels as well as process emissions caused when producing the good. Indirect emissions from the consumption of electricity are covered for selected sectors only. In the transitional period (2023 – 2025) only reporting requirements apply, from 2026 importers of CBAM goods will begin to pay a share of the EU ETS price of carbon corresponding to their embodied carbon emissions minus any carbon prices they have already paid in their home countries. The share of embedded emissions importers have to pay for increases over time at the same pace as free allocation is reduced for these products manufactured in the EU, so that liabilities per tonne of emissions are the same for foreign or domestic entities.

The introduction of the CBAM is an important step to prepare the EU ETS 1 for a cap in line with a 2040 target (i.e. free allocation at today's levels would be unsustainable beyond 2030 as the ETS cap declines to zero). Free allocation has also led to certain distortions of incentives that have reduced the price signal of the emissions trading scheme and thus the incentive to reduce emissions in the industry sector. Allowances no longer allocated for free will be auctioned and the proceeds will feed the innovation fund, which will generate considerable additional revenues per year to support innovative low-carbon technologies in Europe.

The Commission shall assess whether to include further products in the CBAM in the future such as polymers and organic chemicals by 2027, as well as products further up (precursors) or down the value chain in covered sectors. From 2030 onwards, all industrial sectors currently receiving free allocation shall - in principle - be included into the CBAM mechanism (although it remains to be seen at what rate).

Also, the inclusion of indirect embedded emissions for those sectors that currently qualify for indirect compensation under state aid rules shall be considered with the next CBAM review. With electrification in industry being an important emission reduction measure, not including it could raise issues of equal treatment among different production routes and weaken the effectiveness of the CBAM. Especially in the case of electricity there is a concern that producers in third countries could - under existing CBAM reporting rules contained in the implementing acts - claim to use renewable electricity while they continue business as usual.

According to the CBAM Regulation, imports from countries with emissions trading schemes linked to the EU ETS can be excluded from the scope of the CBAM. To date only countries forming part of the EU ETS or being linked to it, are exempted. But this provision as well as the recognition of carbon prices paid in third countries appears to be already encouraging other countries to adopt similar measures.

However, some weaknesses of the CBAM remain to addressed. Most notably, the CBAM includes no mechanism to protect export of goods produced in the EU from carbon leakage risk. In the future, under existing rules exports will neither be covered by free allocation nor protected by the CBAM. Therefore, there is a debate whether exports could receive some sort of support, e.g. an export rebate for the carbon cost paid in the EU. There are concerns that this will be challenged at the WTO and found to be in breach of the Agreement on Subsidies and Countervailing Measures (ASCM) . These legal concerns are disputed: it may be a case of a mis-definition of the instrument as an “export rebate“, i.e. the rebate assumed to be a stand-alone measure for legal analysis. The export measure would be part of a broader instrument (the CBAM) that treated imports and exports symmetrically and could be legal under Article XX of the GATT. Given the less obvious legality of such a mechanism, the rebate might be used as a pretext by bad faith actors to attack the CBAM via retaliation. For now, a compromise was reached in the CBAM Regulation: exporters will receive preferential access to ETS Innovation Funds to help them decarbonise. Furthermore, the Regulation states that the EU Commission shall monitor the situation and report to the European Parliament and the Council and if necessary, propose measures to reduce the carbon leakage risk for exporting industries. The EU will need to begin developing a lasting solution to this issue. Should the EU be concerned about foreign retaliation, one solution may be to work with likeminded partners via international fora, for instance, the OECD Climate Club.

Finally, significant work will need to be done to assess and improve the CBAM and to manage the international relations aspects of the instrument as part of a learning by doing process. It is a necessary and useful, but nevertheless extremely complex and challenging, instrument. The introduction with a reporting phase without surrendering requirements builds on the experience with the EU ETS that the introduction of such a complex system should incorporate a learning phase and the rules improved as experiences are made along the way.

Key questions:

- Which additional industrial sectors currently receiving free allocation should be included in the CBAM from 2030 onwards and at what rate?
- If no export rebate is adopted under the CBAM, what policies can be used to reduce the carbon leakage risk for exporting industries?
- How can the international relations aspects of the CBAM be managed?

Emission factor for biogenic CO_2

In the past, the emission factor for biomass combustion in the ETS 1 was set at zero. With the revision of the ETS Directive in the FF55 package, this zero-rating is limited to sustainable biomass only as defined in the Renewable Energy Directive (RED III). Biomass can only be reported with a CO_2 emission factor of zero if a greenhouse gas emission saving of at least 70% compared to a fossil reference process is achieved. The 70% rule uses a life-cycle approach and cannot be determined using the UNFCCC inventory. Emissions from non-sustainable biomass combustion are reported in the LULUCF sector as a loss of stored carbon. They are not recorded in the energy sectors to avoid double counting. For forests, carbon sequestration takes many decades. Moreover, the existing zero emission factor implicitly assumes that the harvested area is fully reforested, that soil carbon content does not decrease, and that the methods and data sources used for determination are sufficiently accurate. However, this is often not the case (Matthes 2021). Furthermore, biomass combustion, particularly wood, is counterproductive in light of the goals for natural sinks.

Changing the zero-rating for biomass in the ETS would have consequences for the accounting of negative emissions. If all biomass is treated like fossil fuels, emissions could only be mitigated by CCS but it would not be possible to create negative emissions through BioCCS.

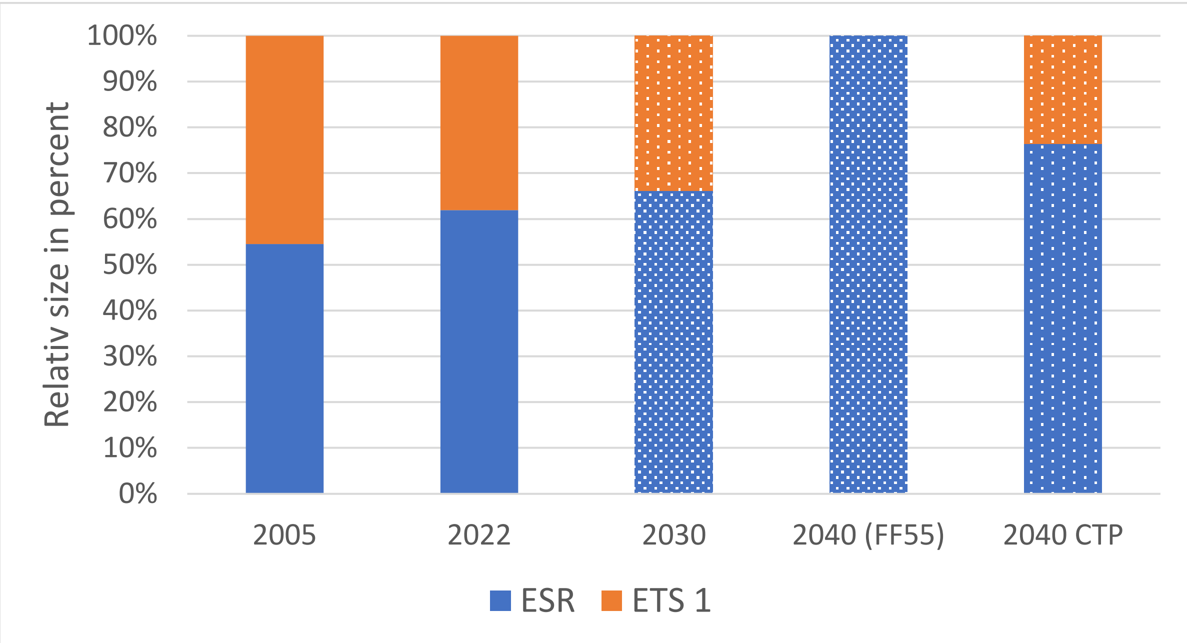
Key questions:

- Should the zero-rating of sustainable biomass in the ETS continue or should all biomass be treated like fossil fuels?

4 Effort Sharing sectors

The Effort Sharing Regulation (ESR) covers all greenhouse gas emissions outside the ETS 1 with the exception of the LULUCF sector, aviation and international shipping. It sets Member State specific emission reduction targets which reflect their ability to pay. Bulgaria, as the country with the lowest GDP/capita in the EU, needs to reduce emissions in the year 2030 by 10 % compared to 2005. The richest Member States need to achieve an emission reduction of 50 %. Transport and heating are the largest sectors covered by the ESR with a relative share of 35 % and 25 % (EEA 2023b). Agriculture follows in third place with 18 %. Energy installations, industrial processes, manufacturing and construction as well as waste are each responsible for 5 % to 6 % of total ESR emissions. The sectors covered by the Effort Sharing Regulation (ESR) will increase in importance in the future. As highlighted in the previous section, ETS 1 emissions have experienced a significant decline in the previous decades. Going forward, ETS 1 emissions are expected to decline at a faster rate than in the ESR, while the ETS 1 cap path (if left unchanged) will lead to (net) zero emissions by 2040. As a result, by 2040 all remaining emissions (except for LULUCF) would come from the ESR sectors (Figure 12). The figure also shows the split of ETS and ESR emissions 2040 based on the Commission's climate target plan.

Figure 12: Relative size of ESR and ETS 1 between 2005 and 2040



Notes: The 2030 share is based on the ETS cap and ESR target.
Source: Öko-Institut with data from EEA (2023a) and Graichen (forthcoming)

The introduction of the ETS 2 changes the situation of the ESR completely as it sets a similar level of stringency for the majority of the emissions under the ESR. Outside of the ETS 2, the major source of emissions is the agriculture sector which has not achieved significant emission reductions in the past. For these reasons, we discuss the ETS 2, agriculture and the remaining emissions under the ESR separately in the following chapters.

4.1 ETS 2

4.1.1 Introduction

The new ETS 2 for road transport, buildings and other sectors will start as a parallel system to the existing ETS 1 in 2027. At 1 040 million allowances the cap will be somewhat lower than the ETS 1 cap of 1 125 million allowances (incl. aviation and shipping) for that year. The initial cap will depend on the share of ETS 2 emissions in total ESR emissions in the years 2016 – 2018, the ESR target for 2024 and the annual reduction rate for the cap (LRF). In 2028, the cap will be recalculated based on monitoring data for the sectors covered by the ETS 2.[9] From then on, the cap will reduce by 5.35 %, reaching zero by 2044.[10]

Figure 13 shows the sectoral distribution of emissions in the ETS 2 in the year 2019. With 56 % of historic emissions, road transport is by far the largest sector covered by the ETS 2. Emissions from fuel consumption for heating and cooking in buildings - separated by residential and commercial/institutional buildings – were responsible for one third of the total. Emissions from the combustion of fossil fuels in small installations both in the energy and industry sectors are responsible for another 12 %. These categories include installations from industry sectors covered by the ETS but that fall below the minimum size thresholds of the ETS 1. The figure also shows the distribution of the ETS 2 emissions across Member States. Germany is responsible for almost a quarter of all emissions, followed by France with 16 % and Italy with 13 %. These three countries together with Poland and Spain (8 % each) are currently responsible for 70 % of the total ETS 2 emissions.

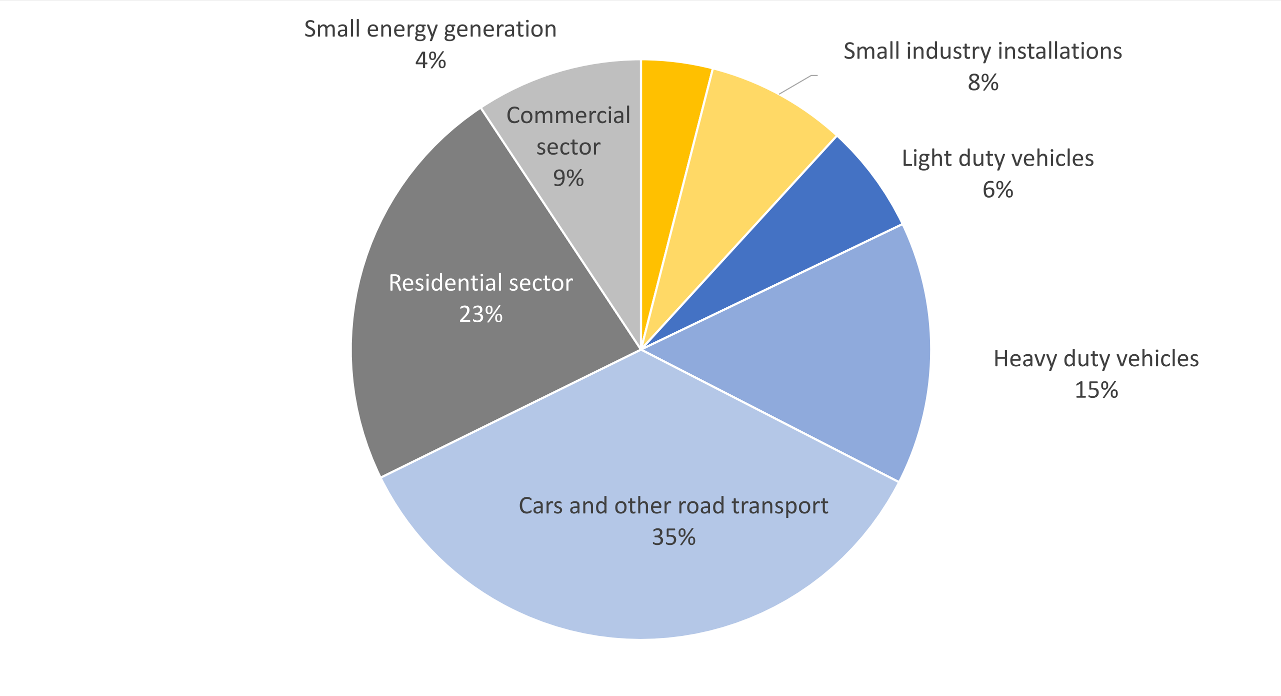
The relative emission development since 2005 is surprisingly similar across all sectors with the exception of energy installations, which have seen a steep increase in emissions since 2005 (Figure 14).[11] The ETS 2 cap development is shown in Figure 16 further below.

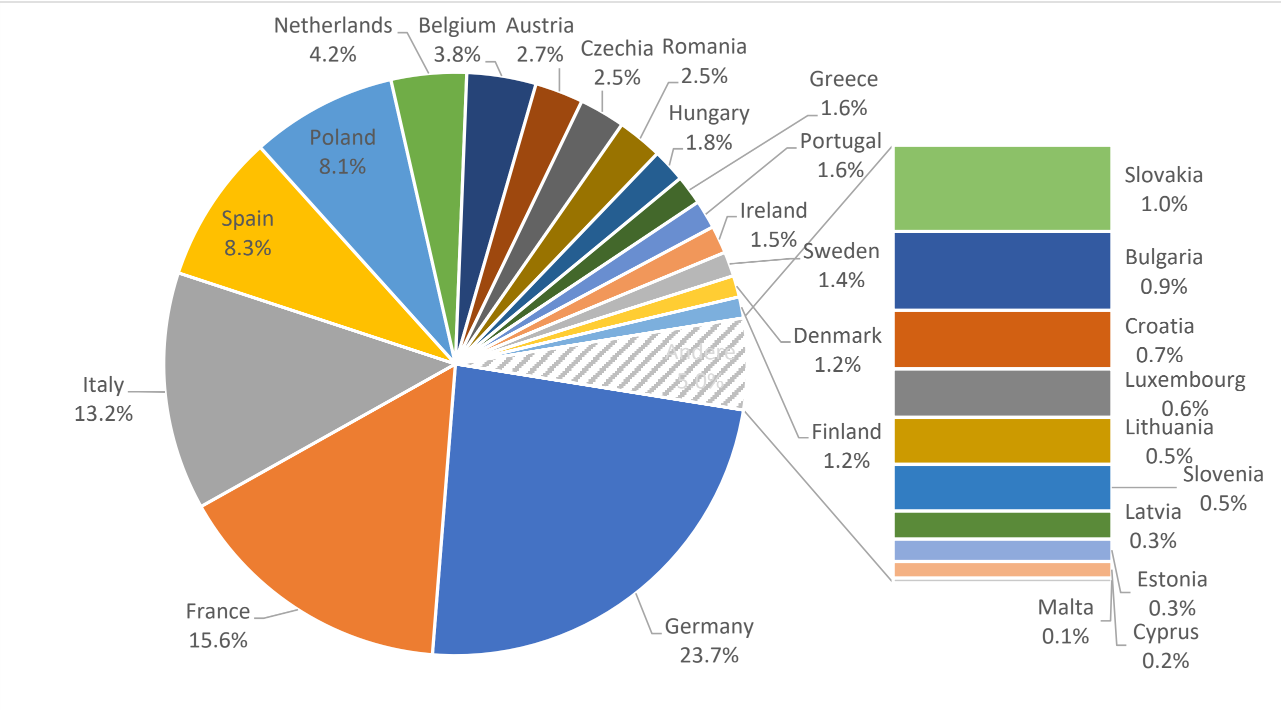
9 The recalculation of the cap is a safe-guard against uncertain historic emission levels in the scope of the ETS 2 once verified emissions become available. In theory, if the estimate for 2016-18 is correct, the recalculation should have no impact on the annual reduction of the cap in absolute terms.

10 For a detailed discussion of the cap in the ETS 2 see

11 The steep increase of emissions from energy installations after 2005 might be linked to the ETS 1 – some operators might have opted for smaller boilers below the minimum threshold of 20 MW to evade the carbon pricing scheme.

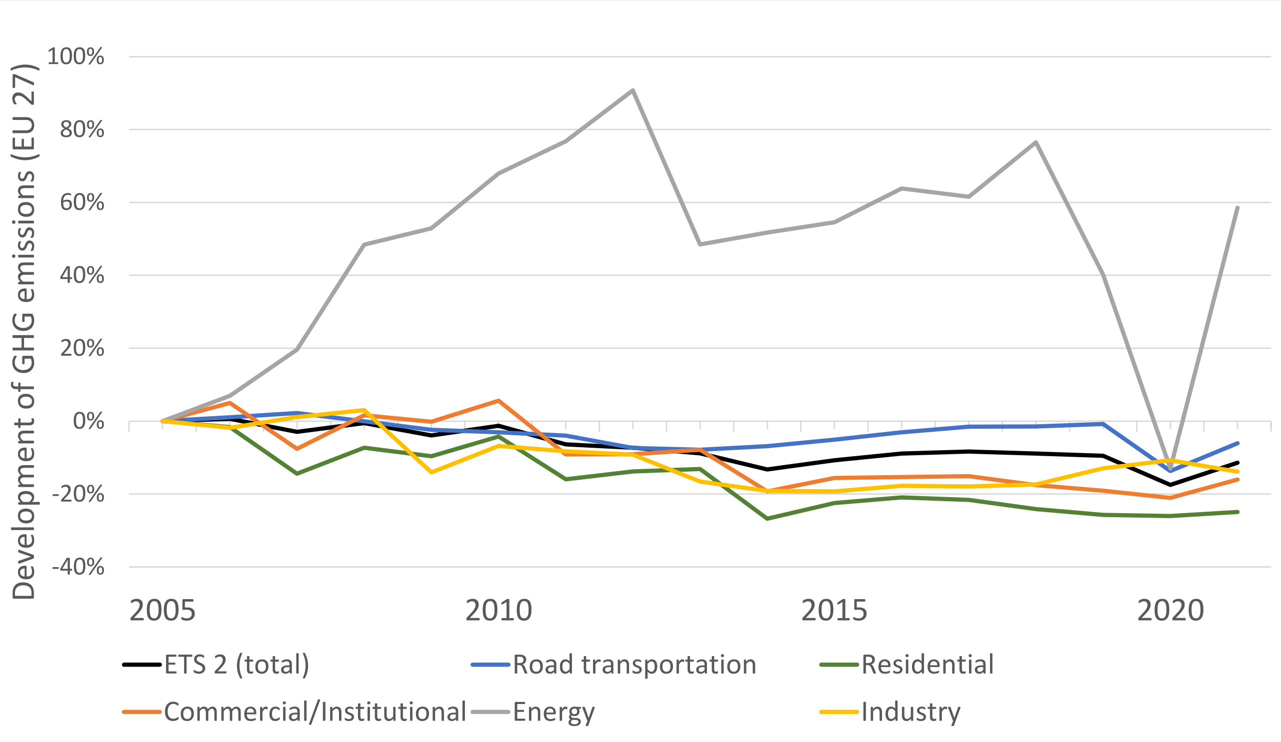
Figure 13: Relative size of ETS 2 emissions by sector and by Member State in the year 2019





Note: Emissions from aviation and shipping are not included.
Source: Öko-Institut with data from EEA (2023a) and EEA (2022)

Figure 14: Development of ETS 2 emissions by sector between 2005 and 2020



Source: Öko-Institut with data from EEA (2023a)

4.1.2 Issues to resolve for 2040 target/architecture

Scope:

The two ETS-systems cover nearly all energy related greenhouse gas emissions in the EU (excluding aviation and shipping) (Table 1). Only 7.5 % of total energy-related greenhouse gas emissions are not yet covered by an ETS, split roughly in equal sizes between not yet included CO_2 emissions and non-CO_2 emissions from the combustion of all fossil fuels.

The only relevant CO_2 emission source from combustion not yet covered is the sector 1.A.4.c Agriculture/Forestry/Fishing, which mainly covers heating and cooling in agricultural buildings, off-road vehicles used in agriculture and forestry and fuel consumption in fishing vessels (Figure 15).

While CO_2 is the main greenhouse gas created in combustion processes, there are also emissions of N_2O and CH_4. These emissions depend on the combustion technology and process conditions, including the quality of seals and fittings and the load factor amongst others. For example, N_2O generation increases with combustion temperature and incomplete combustion of natural gas leads to CH_4 emissions. So far, these emissions are not included in either EU ETS. The largest source of these non-CO_2 emissions is the UNFCCC Common Reporting Framework (CRF) category 1.A.4 Other sectors (buildings, commercial and agriculture/forestry/fishing).

In terms of data availability and quality, monitoring of non-CO_2 emissions from combustion processes is more complex than for CO_2 emissions. In contrast, for CO_2 emissions it is enough to know the physical properties of the fuel to quantify the emissions with high certainty. While quantification of

N_2O and CH_4 might be more complex, these emissions will decline together with a phase-out of fossil fuels. Assuming a near complete phase-out of fossil fuels in the EU by 2050, the main remaining source of non-CO_2 emissions from combustion will thus be linked to the usage of biomethane, biofuels, hydrogen, hydrogen derivatives, as well as the remaining fossil fuels used in CCS installations.

The other share of energy related emissions not yet covered by an ETS are fugitive emissions from fuel production, transportation, distribution, and post-meter leakage. These include methane from coal mines as well as oil and gas operations, which can be expected to decline together with the decline in demand for fossil fuels. As most of these emissions are generated in the (upstream) production process and the EU has a high degree of import dependency for fossil fuels,[12] most of these emissions are also generated outside of the EU and thus outside the scope of the European climate target. The European Commission proposed a Methane Regulation (EC 2021b) as part of the second Fit for 55 package in December 2021, which has recently achieved a trilogue negotiation outcome between the European Parliament and the Council of the EU. The negotiation outcome foresees not only significant new requirements with regards to addressing methane leakage in domestic coal, oil and fossil gas production in the EU, but also a process for potentially more strongly regulating upstream methane leakage from imported fossil fuels by applying equivalent monitoring, reporting and verification measures to exporters to the EU by 2027 and establishing maximum methane intensity values for imports by 2030 (EUCO 2023). When adopted, this law will help reduce methane leakage from the energy sector in the EU and abroad. At the same time, some important gaps remain, such as the regulation of methane leakage from biomethane supply chains, which some studies have found to have significantly higher methane leakage than fossil fuel supply chains (Caroline Brogan 2022).

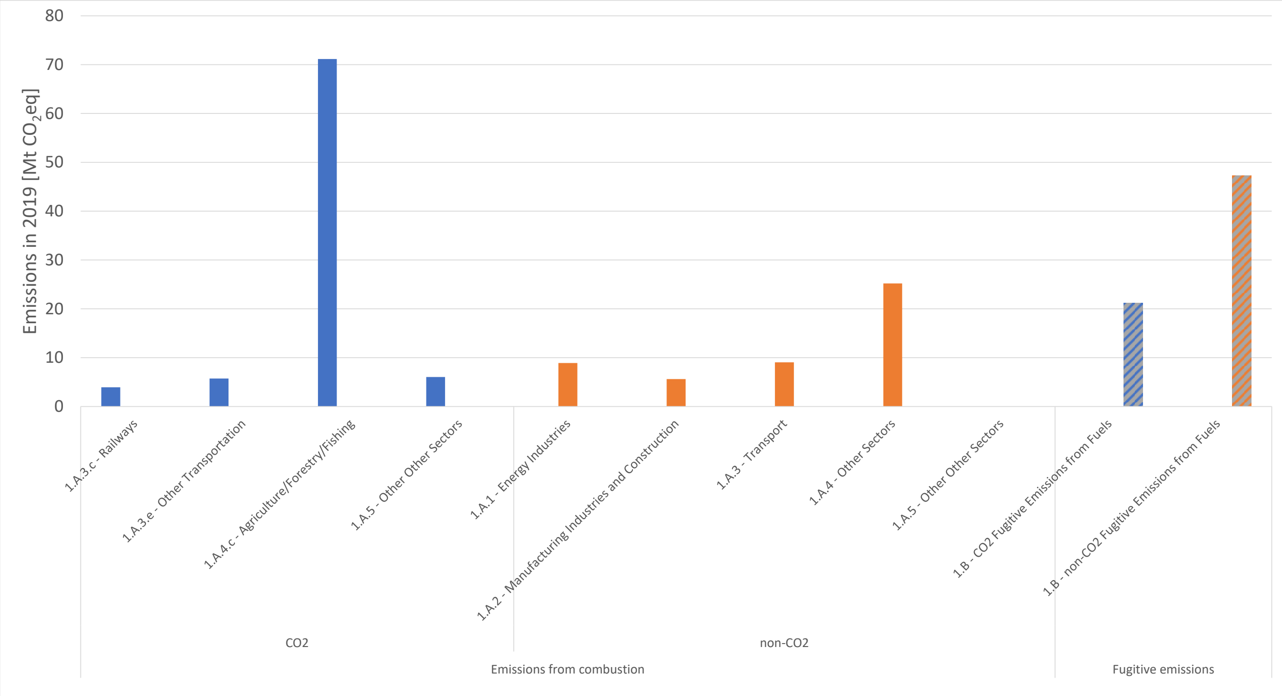
Table 1: Coverage of energy related emissions from fossil fuels in 2019

	Mt CO_2eq	Share [%]
ETS 1 stationary	1 159.1	42.4%
ETS 2	1 368.4	50.1%
CO_2 outside of any ETS	108.0	4.0%
Non-CO_2 from combustion	95.6	3.5%
Total	2 731.1	100%

Note: Emissions from aviation and shipping are not included in this table.
Source: Öko-Institut with data from EEA (2023a) and EEA (2022)

12 The import dependency in 2020 for the EU 27 was 97 % for oil, 84 % for fossil gas and 36 % for coal (Eurostat 2023).

Figure 15: Fossil fuel related emissions outside of the EU ETS in 2019



Note: Emissions from aviation and shipping are not included.
Source: Öko-Institut with data from EEA (2023a) and EEA (2022)

Not included in the table and graph are emissions from aviation and shipping. For aviation, there are three groups of emissions:

- Emissions already covered by the ETS 1: commercial flights above certain size limits (for aircraft/operator) on routes within the EU.
- Emissions covered by CORSIA (implemented through the ETS 1): Flights to third countries will either be covered under CORSIA or fall under the full scope of the ETS 1 (i.e. full inclusion of emissions from both directions into the ETS).
- Emissions from excluded flights: Emissions from flights below the de-minimis thresholds, between outermost regions and their motherland, related to governmental activities (e.g. military) and some other flights (e.g. for testing new aircraft or emergency services) are excluded. These emissions are also excluded from the ESR, i.e. not covered by any target or mechanism except for the EU's overall NDC target.

For shipping, there are only two categories:

- Covered by the ETS 1: All emissions from ships above a de-minimis size at berth, between Member States and 50% of emissions to/from third countries.
- Excluded from the ETS 1: Ships below the minimum size thresholds (this includes all inland shipping), fishing vessels and some other ships/activities. For domestic activities, these emissions are included in the ESR; intra-EU activities outside of the ETS 1 are not covered by any target.

The ETS 2 already includes stationary installations in sectors which participate in the ETS 1 but fall below the minimum size thresholds. Similarly, it would be possible to extend the ETS 2 to the emissions from aviation and shipping not yet covered by the ETS 1.

For both sectors, there is no reliable data on the quantity of emissions not covered by the ETS; UNFCCC inventory reporting is based on a different scope and cannot be used. This is also an issue when trying to define the 2030/2040 target in relation to historic emissions: for 1990, there is no information on emissions from these sectors beyond domestic/international at national level. For more details, see Wissner and Graichen (2024a) and Wissner and Graichen (2024b).

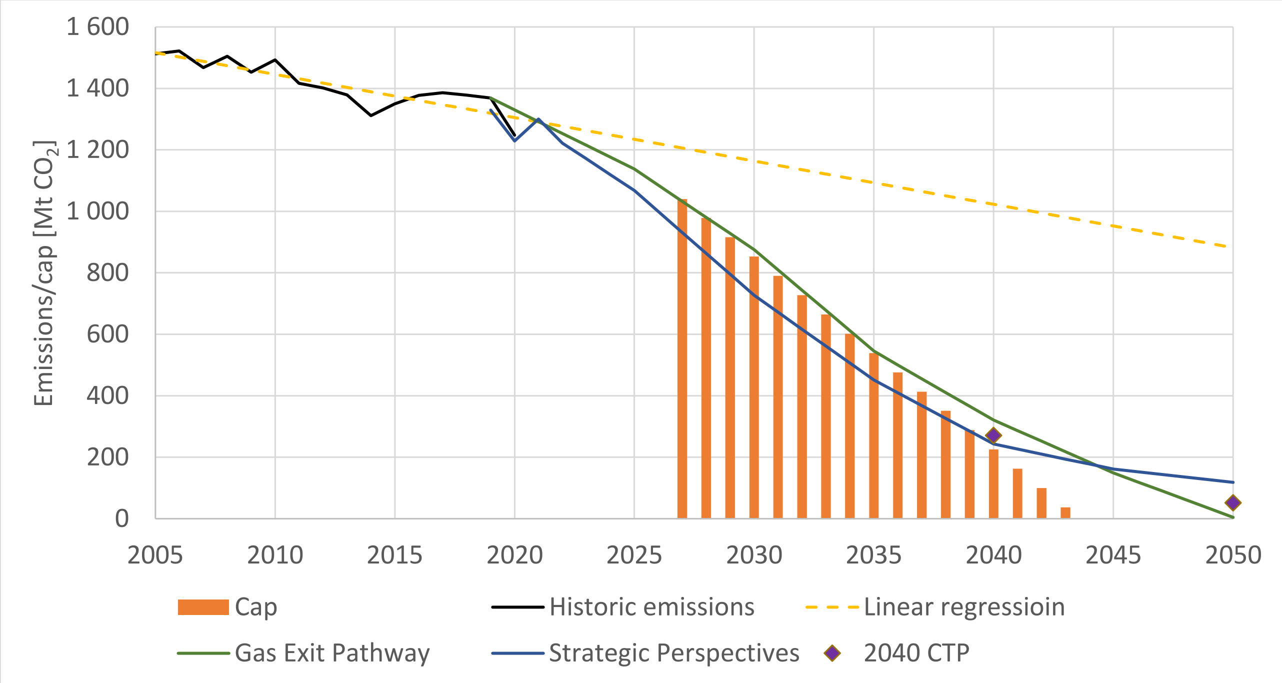
Key questions:

- How should the future framework take into account CO_2 and non-CO_2 emissions (i.e. N_2O and CH_4) from the combustion of fossil fuels that are currently not covered by the ETS 1 or ETS 2? Should fossil CO_2 emissions from the Agriculture, Forestry and Fishing be integrated into the ETS 2, a possible ETS 3 for agriculture, or should they remain solely covered by the ESR?
- How should the future framework address upstream emissions from fuel production, transportation, distribution, and post-meter leakage that are also not covered by the EU ETS? Should the scope of the ETS 1 or ETS 2 be expanded to cover these emissions, or are these emissions already sufficiently governed by the recently agreed Methane Regulation?
- If upstream emissions from fuels are to be governed by the Methane Regulation, how would it need to be strengthened and complemented to address upstream emissions from, e.g. biomethane and hydrogen, that are not covered by the Regulation?
- Some emissions from combustion especially in aviation and shipping are not yet included in either ETS. In part, these emissions also fall outside the ESR, such that they are not covered by any target. The ETS 2 already includes stationary combustion installations in sectors which participate in the ETS 1 but fall below the minimum size thresholds. Similarly, should the ETS 2 be extended to the emissions from aviation and shipping not yet covered by the ETS 1?

Cap and linear reduction factor (LRF)

The cap development requires steep emission reductions in the sectors covered by the ETS 2 compared to historic emission reductions: Between 2009 and 2019, the annual reductions rate was 8.4 Mt CO_2/year across the EU 27. For the period 2010 to 2020, which includes the steep emission decline in 2020 due to the COVID19 pandemic, the annual reduction rate was 24.5 Mt CO_2/year, almost three times as high. Despite this, the required reductions to meet the cap of 62.8 Mt CO_2/year are still more than twice as high as that value (Figure 16). If the LRF remains unchanged, the ETS 2 cap would reach zero by 2044. Compared to the emission development modelled for the study *Breaking free from fossil gas* (Graf et al. 2023), cap and projections match quite well until 2035; until then there would be a cumulated deficit of 92 Mt CO_2 or 1.3 % of the cap 2027 to 2035. After 2035, the emission projection declines much slower than the cap. By 2040, the cumulated deficit would be 392 Mt CO_2, by 2045 1 182 Mt CO_2 and by 2050 1 494 Mt CO_2. The 90 % emission reduction by 2040 pathway from Kalcher and Makaroff (2023) shows even steeper reductions, in this scenario emissions remain below the cap until 2035. After 2040 emissions almost stabilise with 118 Mt CO_2 remaining in the year 2050. The Commission's 2040 climate target plan projection for 2040 is close to the ETS 2 cap based on the current LRF. In the period after 2040 a larger deficit would occur.

Figure 16: Historic emissions, cap and projections for the ETS 2



Notes: The Gas Exit Pathway study does not include a specific projection for the ETS 2. We used the relative development from the year 2019 until 2050 of the transport, buildings and energy sectors to extrapolate the ETS 2 emissions over this time period.
Source: Öko-Institut with data from EEA (2023a), EEA (2022), 90 % scenario from Kalcher and Makaroff (2023), Graf et al. (2023) and Graichen (forthcoming).

Looking at these figures, this leaves three options with regards to the ETS 2 cap post-2030:

- Keeping the ETS 2 cap as it is and significantly accelerating climate action up until 2044 to achieve steeper emission reductions in line with the cap;
- Adjusting the LRF for the period after 2030 or 2035 to reflect that not all emission from fossil fuels can be abated by 2044; or
- Introducing negative emissions as an element into the ETS 2 from some point after 2030 to allow for a compensation of residual unabated emissions.

These options are not exclusive and could be combined. For a discussion of negative emissions inside (and outside of) an ETS see chapter 5.

Key questions:

- If left unchanged, the Linear Reduction Factor under the ETS 2 means the ETS 2 cap would reach zero by 2044. Even very ambitious climate pathways are not able to remain below the ETS 2 cap, in particular after 2035. Remaining below the ETS 2 cap will thus require a significant acceleration of climate action in the transport and buildings sectors up until 2044. Should an adjustment of the LRF for the period after 2030 or 2035 also be considered to reflect that not all emissions from fossil fuels in the ETS 2 sectors are likely to be abated by 2044?

Price containment mechanisms

According to Article 30h, the ETS regulation lays down several mechanisms to deal with high or rapidly increasing allowance prices:

1. If the average allowance price for three consecutive months is more than twice the average price of the previous six months, 50 million allowances will be released from the MSR (Article 30h(1)).
2. If the average allowance price for three consecutive months is more than three times the average price of the previous six months, 150 million allowances will be released from the MSR (Article 30h(3)).
3. If the average allowance price exceeds 45 EUR_{2020} for more than two consecutive months, 20 million allowances will be released from the MSR (Article 30h(2)). This mechanism is valid until the end of 2029. Before the end of 2029, the Commission has to present a report evaluating the effectiveness of this action and a proposal on possible continuation and/or adjustment to the European Parliament and the Council.

If the conditions from Article 30h(2) are met on the same day as conditions according to Article 30h(1) or Article 30h(3), only the mechanism from the respective paragraphs 1 or 3 of Article 30h will be activated. After allowances are released according to one of the three mechanisms, no additional allowances will be released for the next 12 months (Article 30h(6)). However, according to Article 30h(7), the Commission, together with Member States, may decide to override this rule if the conditions from Article 30h(3) are met again in the second half of those 12 months. In this case, it is possible that allowances are released for any of the three cases described above, depending on which conditions are met.

Given this framework it is likely that the CO_2 price will remain over 45 EUR_{2020}; apart from the Commission's impact assessment (EC 2021a) all studies assessing the impact of the ETS 2 expect prices above 100 EUR_{2020}. Vivid Economics projected that the ETS 2 price would be 140 EUR by 2030 if the ETS 2 cap becomes zero by 2044 as in the current regulation (Braungardt et al. 2022). The Ariadne Project used various models and estimated ETS 2 prices of between 170 EUR and 340 EUR by 2030, but those calculations do not include the full price-reducing impact of complementary policies (e.g. CO_2 standards for cars and trucks) (Jan Abrell et al. 2022). Two scenarios were compared by Rickels et al. (2023): one where the cap is achieved and the CO_2 price reaches 264 EUR by 2030, and another where 415 million more allowances are required until 2030 to keep the CO_2 price below 45 EUR. These results are highly sensitive to the assumptions in the modelling, mainly on how consumers will react to higher fossil fuel costs and the type and effectiveness of complementary policies such as efficiency standards for buildings or labelling schemes. However, the discussion about annual reduction rates above supports the expectation, that the allowance price will need to be significantly higher than €45/t CO_2 to meet the cap.

For several reasons it therefore seems unlikely that the price containment mechanisms will be effective:

- Not once since 2005 have the conditions for the doubling/tripling of the ETS price been met in the ETS 1. A very steep increase of prices is required given that the average price for three months needs to be at least twice as high as the average price in the preceding six months.
- The MSR, which emits the additional allowances if Art. 30h is triggered, is initially filled with 600 million allowances. These allowances will become invalid on 1 January 2031. If there is no intake prior to this date, the MSR will be empty and not be able to issue allowances after

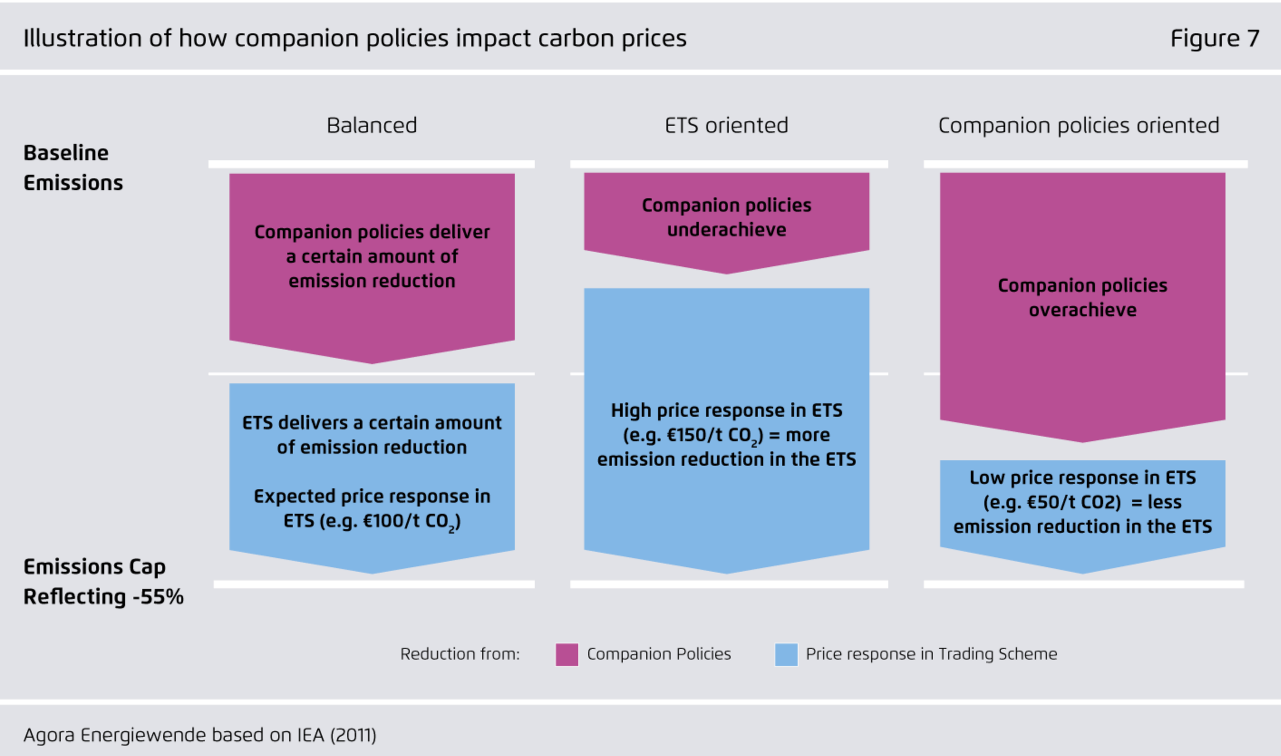
that date. For the MSR to absorb allowances before 2030, actual emissions would need to be at least 130 Mt CO_2 below the cap in 2027/28 (in total).[13]

- The 45 EUR criteria is likely to be met constantly. If released twice per year, the maximum permissible amount, and if the mechanism is extended to 2020 another 160 million additional allowances could enter the market until the end of 2030. This is 3% of the cap in the same period. While this is a relevant quantity it seems too little to significantly reduce the gap between current policies and the cap.

For an in-depth discussion of supply and demand in the ETS 2 and the MSR see Graichen and Ludig (2024)

Unless the two ETS are merged after 2030 (see below), the MSR 2 will either be empty post-2030 or will need to be refilled by allowances created specifically for that purpose. However, creating new allowances to fill the MSR has the same effect as increasing the cap and would thus represent a reduction in climate ambition, which should be avoided. Alternatively, companion policies such as more stringent efficiency standards for buildings and enhanced support schemes for clean heating and mobility could help contain the carbon price, while maintaining and reinforcing climate ambition. These policies would need to be implemented sufficiently early and at scale to have a noticeable effect. An illustration of this is shown in Figure 17.

Figure 17: Relationship between ETS price and companion policies



[13] To ensure liquidity in the market, the auction quantity in the first year will be increased by 30 % (312 million allowances). Between 2028 and 2031 the auction quantities are reduced by 104 million allowances per year. The threshold for the MSR to become active is 440 million, i.e. demand would need to be 130 million allowances below the cap on top of the frontloading quantity to trigger the intake. From 2029 onwards, the compensation of the frontloading makes it even more unlikely that the upper threshold will be triggered.

Source: Agora Energiewende and Ecologic Institute (2021)

Key questions:

- The Market Stability Reserve for the ETS 2 will initially be filled with 600 million allowances, which are to become invalid on 1 January 2031. At the same time the price containment mechanism set up to keep the ETS 2 price in check will likely be a major draw on the MSR 2 before this date. Will the MSR 2 need to be refilled before or after this date, and if so how could it be done in a way that avoids a significant reduction in climate ambition?
- Which EU and national companion policies could help to serve as alternative price containment policies, while maintaining and reinforcing climate ambition? How can these policies be implemented sufficiently early and at scale to have a noticeable effect well before 2040?

Auction revenues and the Social Climate Fund

All ETS 2 allowances are auctioned. The largest share of the auctioning revenues is distributed to Member States, but it is also used to finance the Social Climate Fund (SCF). In total, the SCF should receive 65 billion Euros from ETS 1 and 2 revenues until 2032. The ETS 1 contributes the revenue from auctions of 50 million allowances, the difference to the full budget is filled by the ETS 2. Assuming that the CO_2 price in both systems is at 80 EUR/t, 4 billion Euro will stem from auctioned ETS 1 allowances, while 760 million ETS 2 allowances would need to be auctioned to raise the remaining 61 billion Euro.

The remaining ETS 2 allowances are auctioned by Member States based on their historic emission shares in the years 2016-18. Table 2 shows total auction volumes, the contribution to the SCF (at 80 EUR/t) and the remaining auction quantities by Member State until 2040 (before any MSR intervention).

There are clear guidelines for the use of revenues distributed via the SCF. Firstly, Member States are required to draw up so-called Social Climate Plans for the use of SCF funds. These should contain a coherent bundle of existing and new national measures (and in particular investments) that enable affordable heating and cooling as well as affordable mobility. At the same time, they must also support or accelerate the achievement of EU climate targets (Art. 4 of Regulation 2023/955). The Social Climate Plans are assessed by the EU Commission after being drafted by the countries. The deadline for submitting the drafts is 30 June 2025 (see (17) of EU Regulation 2023/955).

Table 2: ETS 2 auction volumes until 2045 by SCF and Member State

	Share 2016-18 [%]	2027-2030	2031-35	2036-40	2041-2045
		[million allowances]			
Cap		**3 786.9**	**3 322.6**	**1 753.5**	**298.9**
SCF (80 EUR/t)		**508.3**	**254.2**		
Auctioning by MS	**100%**	**3 278.6**	**3 068.4**	**1 753.5**	**298.9**
Austria	2.7%	101.2	88.8	46.9	8.0
Belgium	3.8%	145.4	127.6	67.3	11.5
Bulgaria	0.9%	34.4	30.2	15.9	2.7
Croatia	0.7%	25.7	22.5	11.9	2.0
Cyprus	0.2%	7.3	6.4	3.4	0.6
Czechia	2.5%	96.0	84.2	44.4	7.6
Denmark	1.2%	45.2	39.6	20.9	3.6
Estonia	0.3%	9.7	8.6	4.5	0.8
Finland	1.2%	44.5	39.0	20.6	3.5
France	15.6%	591.2	518.7	273.8	46.7
Germany	23.7%	898.8	788.6	416.2	70.9
Greece	1.6%	61.3	53.8	28.4	4.8
Hungary	1.8%	69.8	61.2	32.3	5.5
Ireland	1.5%	58.2	51.1	26.9	4.6
Italy	13.2%	499.4	438.1	231.2	39.4
Latvia	0.3%	12.2	10.7	5.7	1.0
Lithuania	0.5%	20.5	18.0	9.5	1.6
Luxembourg	0.6%	21.1	18.5	9.8	1.7
Malta	0.1%	2.1	1.8	1.0	0.2
Netherlands	4.2%	158.1	138.7	73.2	12.5
Poland	8.1%	307.2	269.6	142.3	24.2
Portugal	1.6%	59.9	52.5	27.7	4.7
Romania	2.5%	94.7	83.0	43.8	7.5
Slovakia	1.0%	37.7	33.1	17.5	3.0
Slovenia	0.5%	20.5	18.0	9.5	1.6
Spain	8.3%	313.3	274.9	145.1	24.7
Sweden	1.4%	51.5	45.2	23.8	4.1

Source: Öko-Institut

Key questions:

- Will the Social Climate Fund continue after 2032 and, if so, what methodology would be used to determine the relative contribution of each Member State, as well as the ETS 1 vs ETS 2 to its financing?
- Should the parameters of the SCF (size, distribution key) be kept or updated?

Impact of the ETS 2 on ESR targets

Table 3 shows the 2030 ESR targets compared to average emissions 2016-18, the reference period under the ETS 2. In total, a 32 % reduction compared to this reference period is required to achieve the EU-wide ESR targets. The ETS 2 cap 2030 is calibrated to achieve a 38 % reduction compared to 2016-18, more ambitious than the ESR target. If this reduction is achieved equally across the EU in all Member States, the non-ETS ESR emissions would only need to decline by 22 % compared to 2016-18.

Put differently, if ETS 2 sector emissions remain at the cap, it would be enough for the remaining non-ETS emissions of each Member State to only decline by 73 % of their respective ESR target. For example, the ESR target of Belgium is a 41 % reduction compared to 2016--18. The required reduction for the non-ETS sectors would be a reduction of 30 % ($73\% \cdot 41\% = 30\%$). Table 3 illustrates this rule-of-thumb in more detail: staying with Belgium as an example, ETS 2 emissions in 2030 would be 32.8 Mt CO_2, a reduction of 38.2 % compared to 2016--18. The 14.3 Mt CO_2eq of other ESR emissions represent a reduction of 29.9 % below the 20.4 Mt CO_2eq 2016--18.

While only provided for illustrative purposes, this calculation highlights that reducing ETS 2 emissions in line with the cap could lead to a circumstance where the EU wide ESR target in 2030 would be met, but individual Member States would over-/underachieve their national targets. This is because ESR-targets are differentiated by GDP/capita and ability to pay for the richer Member States whereas the ETS 2 cap is assumed to impact all Member States equally. Germany, the country with the highest ETS 2 emissions, also has the highest relative reduction requirement compared to 2016--18. Under the assumptions above, Germany would need to buy 40 million AEA for the year 2030 alone. By contrast, Greece, Poland, and Spain would each be able to sell around 10 million AEA. Assuming that AEA prices are similar to the ETS 2 prices and the price projections cited above come true, this would be an additional revenue stream of several billion Euros for the years 2027--2030.

Table 3: Potential impact of the ETS 2 on ESR targets by Member State

	ESR target		2016-18 emissions		2030 target vs 2016-18		2030		
	vs 2005	vs 2016-18	ETS 2	Other ESR	ETS 2	Other ESR	ETS 2	Other ESR	Surplus
EU-27	**-40%**	**-32%**	**1 380.5**	**841.9**	**-38.2%**	**-22.0%**	**853.1**	**656.7**	**0.0**
Austria	-48%	-42%	36.9	14.0	-38.2%	-30.6%	22.8	9.7	-2.9
Belgium	-47%	-41%	53.0	20.4	-38.2%	-29.9%	32.8	14.3	-3.6
Bulgaria	-10%	-23%	12.5	12.0	-38.2%	-17.0%	7.7	10.0	1.1
Croatia	-17%	-8%	9.4	7.6	-38.2%	-5.7%	5.8	7.2	2.7
Cyprus	-32%	-31%	2.6	1.6	-38.2%	-22.5%	1.6	1.3	0.1
Czechia	-26%	-22%	35.0	28.7	-38.2%	-16.4%	21.6	24.0	3.8
Denmark	-50%	-39%	16.5	17.7	-38.2%	-28.5%	10.2	12.7	-1.9
Estonia	-24%	-24%	3.6	2.6	-38.2%	-17.5%	2.2	2.2	0.3
Finland	-50%	-43%	16.2	13.8	-38.2%	-31.9%	10.0	9.4	-2.4
France	-47%	-40%	215.5	129.8	-38.2%	-29.1%	133.2	92.0	-16.8
Germany	-50%	-46%	327.7	108.1	-38.2%	-34.0%	202.5	71.3	-40.0
Greece	-23%	8%	22.4	23.3	-38.2%	6.0%	13.8	24.7	10.9
Hungary	-19%	-9%	25.4	18.8	-38.2%	-6.7%	15.7	17.5	6.9
Ireland	-42%	-38%	21.2	25.8	-38.2%	-27.6%	13.1	18.7	-2.5
Italy	-44%	-29%	182.0	101.5	-38.2%	-21.5%	112.5	79.6	8.3
Latvia	-17%	-22%	4.5	4.2	-38.2%	-16.2%	2.8	3.5	0.5
Lithuania	-21%	-27%	7.5	6.6	-38.2%	-19.7%	4.6	5.3	0.4
Luxembourg	-50%	-42%	7.7	1.1	-38.2%	-31.1%	4.8	0.8	-0.4
Malta	-19%	-40%	0.8	0.5	-38.2%	-29.5%	0.5	0.4	-0.1
Netherlands	-48%	-34%	57.6	43.0	-38.2%	-25.0%	35.6	32.2	-1.6
Poland	-18%	-24%	112.0	92.5	-38.2%	-17.4%	69.2	76.4	10.3
Portugal	-29%	-15%	21.8	19.0	-38.2%	-11.0%	13.5	16.9	4.3
Romania	-13%	-9%	34.5	43.0	-38.2%	-6.9%	21.3	40.0	8.9
Slovakia	-23%	-14%	13.7	6.5	-38.2%	-10.0%	8.5	5.8	3.2
Slovenia	-27%	-22%	7.5	3.8	-38.2%	-16.1%	4.6	3.2	1.0
Spain	-38%	-25%	114.2	82.3	-38.2%	-18.3%	70.6	67.2	9.7
Sweden	-50%	-33%	18.8	13.4	-38.2%	-24.1%	11.6	10.2	-0.2

Note: Emissions/targets are in Mt CO_2eq.
Source: Öko-Institut

Key questions:

- Under the 2030 climate policy architecture, lower-income Member States may be able to achieve additional revenues from selling surplus ESR AEA allowances to higher-income Member States with more ambitious national targets. In the post-2030, can and should differentiated national targets under the ESR serve as an additional support for lower-income Member States to achieve emissions reductions in line with the ETS 2 cap?

Impact of the ETS 2 on poorer Member States

However, it seems unlikely that the ETS 2 impact will be homogeneous across all Member States. In theory, the price signal should lead to three main reactions:

- Behavioural changes: The simplest reaction to higher fuel prices would be a demand reduction through changed consumption patterns, including through easy to implement measures such as using hot water more efficiently, avoiding the heating of unused rooms and driving less through bundling trips.

- Fuel switching and modal shift: Where possible, a switch to cheaper fuels using existing infrastructure would be incentivised, including through the switching of supply contracts and the use of alternative fuels in multi-fuel boilers. In the transport sector, a modal switch to non-motorised or public transport would be an option if and where sufficient public transport exists. In homes with central heating and wood stoves, these stoves may be used more than before, which may also in part encourage the use of less efficient and more polluting forms of heating (e.g. solid biomass).
- Investments: The carbon price would also incentivise investments into new or used low carbon technologies, e.g. heat pumps, better insulation and electric vehicles (EVs) that are not impacted by the ETS 2 and/or reduce fossil fuel emissions covered by the ETS 2 where households and business are able to afford to make these investments.

Due to the large income disparity between Member States, the uniform price signal of the ETS 2 is likely to trigger stronger behavioural changes in the poorer Member States. For the populations in these countries, the relative price increase is higher due to generally lower fuel taxes and therefore likely to send a stronger (initial) price signal, while the ability to pay higher prices is also much lower due to lower disposable income levels. If not counteracted by other policies and measures, this sudden change in the price of fossil fuels for heating and transport risks increasing fuel poverty in the lowest income strata of the population, as well as for middle-income households living in particularly poorly insulated buildings or facing a heavier car dependency (e.g. in many rural areas). This shows that other policies that allow for adapting to this price signal are especially warranted in these Member States and regions and that sufficient financing needs to be foreseen for this.

When it comes to investments, the expected effect is the other way around: The wealthier income groups will – all else being equal – be more likely and able to invest in new low-carbon technologies. At the same time, due to the large number of very small point sources (i.e. each ICE car, each gas stove, each coal boiler) that will need to be replaced, it will take time until a larger share of the population is actually able to adopt these new technologies.

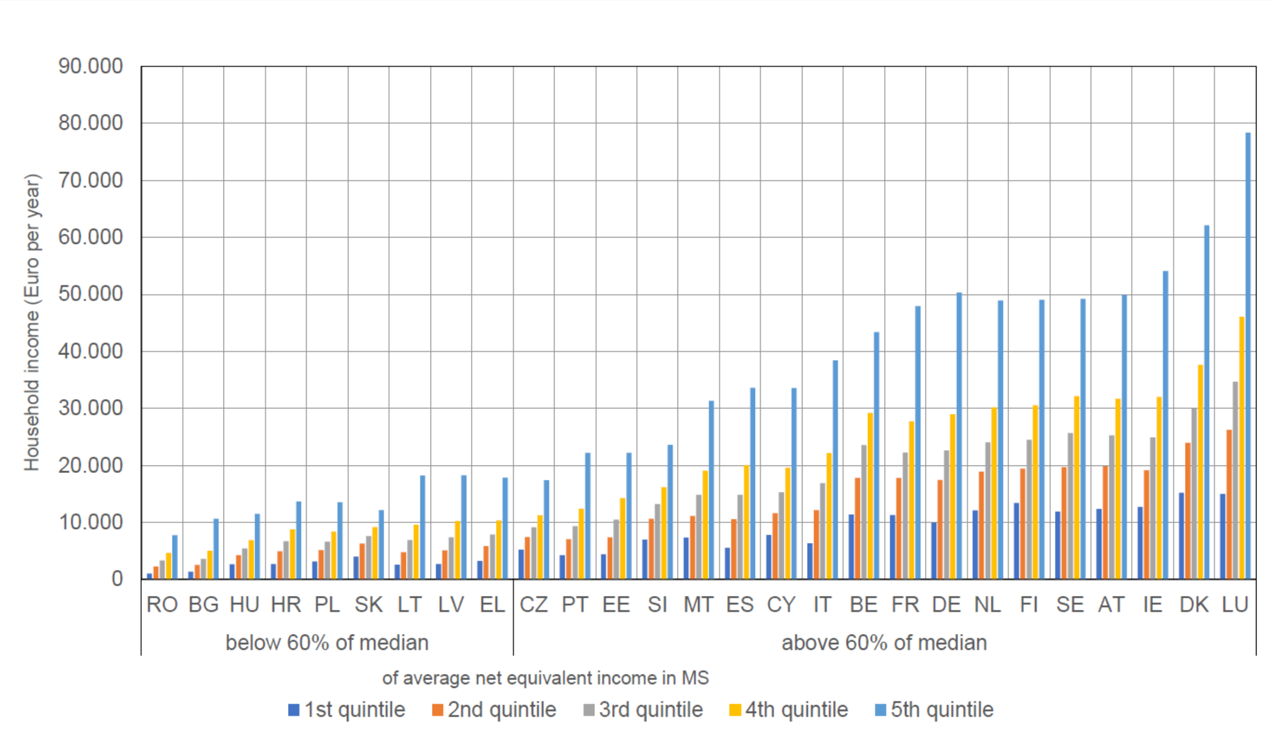
As a result, with the ETS 2 starting only in 2027 it seems likely that a reduction in demand through user behaviour will be a key response to the ETS 2 cap and prices until 2030, i.e. the relative response by consumers directly attributable to the ETS 2 will be higher in poorer Member States. Such behavioural modification would imply two additional revenue streams:

- Poorer Member States would be able to sell more AEA; and
- There would be a net flow of ETS 2 allowances out of these countries, i.e. a net transfer of revenues towards these Member States.

If some of these “additional” revenues, together with the revenues from the Social Climate Fund, are used to directly support the most vulnerable population through direct income transfers or investment support, the danger of particularly heightened fuel poverty could be averted. However, safeguarding these households will depend on the willingness and ability of their governments to use the revenues in for these purposes, and effectively identify, target, and reach those households in greatest need.

The large differences in mean net equivalent income are shown in Figure 18. Even the highest quintile in the three poorest Member States have – on average – a lower net equivalent income than the lowest quintile in the ten richest MS.

Figure 18: Mean net equivalent income per year across Member States and income quintiles



Source: Braungardt et al. (2022)

So far, the SCF is only financed until 2032 whereas the ETS 2 has no time limit. Poorer households will need continued support beyond the current duration of the SCF, i.e. it will be necessary to replenish the fund or introduce new solidarity schemes in the EU. Another weakness of the SCF is its fixed size. Consequently, even at very high CO_2 prices, the SCF will not be able to provide more support as the agreed upon amount of 65 billion Euro which is independent of the level of carbon costs. The size of the SCF was set to approx. 25 % of the auctioning revenues at a CO_2 price of 50 EUR/t, much lower than the anticipated prices. The SCF share would decline to 12 % with an average carbon price of 100 EUR/t and to 8 % with a carbon price of 150 EUR/t.

Key questions:

- The Social Climate Fund has been capped at 65 billion Euro, which reflects roughly 25% of auctioning revenues at EU ETS 2 price of 50 EUR/t. Should the size of the SCF be expanded to reflect the need to scale support targeted to lower-income households and member states in line with higher expected carbon prices?

Integration of ETS 1 and 2

Whether to combine or keep separate the ETS 1 and ETS 2 is another open issue. Economic theory suggests that a larger scope would lower the overall costs and increase the economic efficiency. The reason for having parallel systems at first was to avoid any unexpected development in the ETS 2 that could harm the effectiveness of the ETS 1. Without reliable data on actual emissions in the ETS 2 scope, there are inevitable uncertainties. Especially the basis for setting the cap, historic emissions in the period 2016-18, will always be an estimate using assumptions. The demand and the resulting CO_2 price in the ETS 2 are also uncertain. The experience of the ETS 1 has shown that it can take well over ten years to ensure that a new ETS functions properly. At least in the short run, merging an immature ETS 2 with a mature ETS 1 therefore comes with risks of importing these uncertainties into the ETS 1. This might not only be to the detriment of environmental effectiveness, but also to the commercial strategies of ETS 1 companies, to Member State and EU revenue generation, and the effectiveness of related policy tools such as the CBAM.

There are also other reasons for having separate emission trading systems even in the longer term:

- Risk of excessive prices for some sectors: Some sectors might have a much higher willingness and ability to pay than others, and a merged ETS could have unintended consequences. For example, in road transport, economic efficiency is not the only or even main factor that influences the choice of transport mode and investments by individuals; the choice of car is currently rarely decided by life-time costs including fuel usage. The inflexibility of this sector could lead to very high CO_2 prices in a short time span that could be prohibitive for some households or industry sectors. Currently, the ETS 2 includes price containment mechanisms to take these factors into account, which would be difficult to maintain when merging the two systems.
- Risk of delaying the transformation in some sectors: To reach the EU's goal of carbon neutrality by 2050, all emissions need to be reduced as much as possible. Especially, almost all fossil fuel use will need to be phased out. Some transformations can be done in a relatively short time (i.e. the share of EVs in new passenger vehicle sales), but other transformations have limited speeds. For example, energy renovation of buildings is limited by the availability of qualified personnel and building materials. Merging the ETS 1 and ETS 2 could effectively delay the need to reduce emissions in road transport and buildings by indirectly placing the responsibility to reduce emissions even more strongly on sectors covered by the ETS 1. However, once other reduction options have all been used up, it might not be physically possible anymore to achieve the transformation of the ETS 2 sectors before 2050.
- Risk of carbon leakage: The risk of carbon leakage, i.e. that emissions are transferred to countries outside the EU due to the ETS, is very different between the sectors. A trip between Paris and Brussels cannot be replaced by a trip outside of the EU, very few people will emigrate to third countries due to a high ETS price. For some industry emissions this is different: Sudden high carbon costs without sufficient protections could lead to a shift of production to factories outside of the EU. In general, the carbon leakage risk in the ETS 2 is much lower than in the ETS 1 which means that higher carbon prices could be possible. Therefore, it can be argued that they should be kept separate – at least until the CBAM is fully in place and free allowances have been phased out – in order to better be able to take these factors into account. This would especially be the case if integrating the two systems would lead to increased pressure (i.e. higher prices) for industry in global competition.

Concerning the post-2030 climate architecture, it should also be borne in mind that the start of the ETS 2, which is only in 2027, will be too late to provide timely input into the review of the ETS for the period after-2030. In other words, if a merger between the two systems is planned for 2031 already, there would only be very limited new information available compared to the situation during the introduction of the ETS 2.

To be able to merge the two ETS, some practical challenges would need to be resolved. These include the integration of upstream and downstream monitoring into one system, the merger of two MSR, the setting of a combined cap and the distribution of auctioning quantities across Member States. While non-trivial, all these issues could be solved without major problems.

Alternatively, the two systems could be kept apart but linked through a limited flexibility. This could take the form of a maximum net flow of allowances between the two systems or the possibility to use allowances from the other system if price differences exceed a certain threshold.

Key questions:

- Should the ETS 1 & ETS 2 be merged, be kept as completely separate systems or partially linked through a limited flexibility?
- If the systems are partially or fully merged, how can the risk of excessive prices in some sectors and delaying transformation in other sectors. Would merging increase the risk of carbon leakage in energy intensive industries due to excessive prices?
- How could the upstream (ETS 2) and downstream (ETS 1) monitoring systems be merged into one system?
- How can the two MSR systems be merged into one system?
- How would the setting of a combined cap and the distribution of auctioning quantities across Member States work in a combined system?

4.2 Agriculture

Long-term relevance of the agricultural sector

Agriculture is the largest sector subject to the Effort Sharing Regulation (ESR) for which there is no follow-up regulation for the period after 2030. The emission inventories attribute only a part of agricultural activities directly to the agricultural sector (CRF category 3). These emissions caused about 10.2 % of the EU's GHG emissions (EEA 2021) (see Figure 1). Approx. two third of this come directly from livestock (enteric fermentation and manure management – CRF 3A and 3B) and N_2O emissions come from soil fertilization (CRF 3D). The remaining sources only account for less than 5 %.[14]

To date, the agricultural sector has not achieved any significant emission reductions at EU level (Figure 20). As a result, agriculture is expected to be the sector with the highest residual emissions by 2040. This is because nitrous oxide and methane emissions in agriculture arise from natural processes for which there are only limited mitigation techniques available (Scheffler and Wiegmann 2021).

Next to these emissions directly attributed to the agriculture sector, agriculture and forestry activities also bring about further emissions that are recorded in the land use sector. For example, the management of organic soils and the conversion of grasslands play a major role in some regions (EEA 2021).

Finally, emissions from energy use in agriculture, forestry and fisheries are aggregated and reported in UNFCC Common Reporting Framework (CRF) category 1.A.4c. Fuel use for agricultural activities is currently excluded from the ETS 2 and hence it remains largely unregulated for the moment.

[14] The minor emissions categories are *rice cultivation* (CRF 3C), *prescribed burning of savannahs* (CRF 3E), *field burning of agricultural residues* (CRF 3F), *liming* (CRF 3G), *urea application* (CRF 3H), *other carbon containing fertilisers* (CRF 3I) and *other agricultural emissions* (CRF 3J).

The difficulty of setting targets for agriculture

To date, the EU has not set specific GHG reduction targets for agriculture, either in the Effort Sharing Regulation (ESR) or in the Common Agricultural Policy (CAP). Furthermore, the European Court of Auditors has concluded that the EU does not apply the polluter pays principle to GHG emissions from agriculture (ECA 2021a; 2021b).

In view of the scant technical mitigation options, the sector has tended to be assigned a special role in the past. This is visible by the fact that prior to the Farm to Fork-Strategy no vision[15] for agriculture had ever been developed that required a significant economic transformation on environmental grounds. Only with the goal of climate neutrality by 2050 under the European Climate Law has the sector come into the focus of climate policy on the basis that all sectors must evidently contribute to achieving such an ambitious society-wide transformation: Achieving net zero emissions by 2050 will not be possible without substantial reductions in agricultural emissions.

The Farm to Fork Strategy – the key strategy for EU agriculture in the future – also recognizes diets and the high greenhouse gas emissions from livestock farming as areas in which action is needed (KOM 2021). In this context, nutrition is a significant lever for achieving climate neutrality. Not least because animal production is land-intensive, and the globally available agricultural land is a limited resource.

Agriculture policy plays a crucial role in shaping the sustainability and resilience not only of food systems, but also directly impacts biodiversity, which is a vital component of environmental sustainability. Biodiversity ensures ecosystem stability, resilience against pests and diseases, and the provision of ecosystem services such as pollination and soil fertility. Trade-offs can arise between climate and biodiversity objectives within agriculture policy. For instance, the push for biofuels to reduce carbon emissions can lead to monoculture plantations, which decrease biodiversity. Similarly, intensive agricultural practices aimed at maximizing yield can result in habitat destruction and the loss of species. To manage these trade-offs, it is essential to adopt integrated approaches that balance climate goals with biodiversity conservation.

4.2.1 Options for the period after 2030

There are various options for integrating agricultural emissions in a climate regime for the period after 2030.

Option 1 – Target-based approach without pricing

- ***Option 1a - Continuation of ESR***
  The sectors not yet covered by ETS 1 (potentially also ETS 2) will continue to be grouped together and assigned a common target as before. The LULUCF sector, which is covered by the LULUCF Regulation until 2030, also has separate targets (see also chapter 4.4).
- ***Option 1b – Sectoral targets***
  In a similar way to the Effort Sharing Regulation and to the German Federal Climate Change

[15] While the energy consumption sectors can and must reduce their emissions to a large extent completely through savings and the use of renewable energies, there is no comparable, simple recipe for deriving the target for agriculture. Nevertheless, the transformation of energy systems, industry, transport infrastructure etc. is a profound transformation of these sectors. A comparable task has not been set for agriculture in the past.

Act, a reduction pathway with sectoral targets up to 2050 could be set for the agricultural sector.

- ***Option 1c – Setting an integrated AFOLU target for LULUCF and agriculture*** An integrated target would combine emission from the agricultural sector with emissions and carbon removals arising in the LULUCF (Land Use, Land Use Change and Forestry) sector – or only some elements of it.

While the first two options (Option 1a, and Option 1b) build on existing practice, or are relatively straightforward, the final option (Option 1c) of a full integration would be a novel approach. This bears the risk of missing ambition since low-cost removals in forests could offset agricultural or peatland emissions (net-balancing). But the risk of missing ambition could be reduced by two options which should require careful reflection:

- Setting binding sub-targets: Full integration in an AFOLU sector implies that residual emissions from the agricultural sector can be offset by carbon removals from natural sinks in the LULUCF sector. To deal with the high uncertainties especially from forest sinks, separate targets for emissions in agriculture, emissions from land use and carbon removals could be considered in order to set ambitious climate targets.
- Creation of an ALU sector excluding forest emissions: Another point of criticism regarding natural sinks is the permanence of the removals. Natural sinks (e.g. forest biomass) store carbon only for limited periods and CO_2 stays in the atmosphere in parts for more than 1 000 years (Meyer-Ohlendorf et al. 2023a). Therefore offsetting (net-balancing) agricultural or peatland emissions with low-cost but potentially short-lived removals in forests could reduce ambition of GHG-mitigation. Exclusion of forests and a focus on agricultural and LULUC emissions in an ALU sector could be an alternative.

In all cases, a mix of instruments can be used: regulatory law, subsidies (e.g. via the CAP) and carbon pricing. For each of the three options, it is necessary to derive emission targets at Member State level.

Option 2 – Pricing agricultural emissions via taxes or levies

The approach of pricing emissions aims to make greenhouse gas-intensive products more expensive. This can be achieved via taxes, levies or via emissions trading (Isermeyer et al. 2019)[16]. Similar to carbon taxes in various European countries, there could be a fixed price for agricultural emissions, e.g. CH_4 from the digestion of ruminants or N_2O from nitrogen fertilization, in order to incentivize emissions reductions and generate state revenues that could be channeled into supporting additional emissions reducing activities. Under this option there is less control over the development of emissions compared to an emissions trading system with a fixed cap. Periodic adjustments to the price level could be made in order to respond to emission developments but would require political agreement on an emissions reduction pathway. EU harmonisation of minimum tax levels could be achieved, analogous to the Energy Taxation Directive, but would likely be difficult to achieve in practice due to the fact that EU unanimity rule is applied for tax matters.

[16] Isermeyer et al. (2019) also mention the possibility of reward systems (remuneration for emissions below a benchmark). However, this appears comparable to emissions trading with free allocation, in which those who receive more than they need can sell the surplus allowances on the market.

Option 3 - Integration of agriculture into the ETS 2 post-2030

The agricultural sector could be included in the ETS 2, which already covers emissions from transport, buildings, and small installations. Under this option, it is not necessary to define a specific reduction path for the agricultural sector since there is only one emissions cap for all sectors covered by the ETS 2. However, the existing reduction pathway for the ETS 2 (see chapter 4.1.1) would need to be adjusted to make additional emission allowances available to the agricultural sector. This would indirectly set a reduction pathway. Setting national reduction targets for the agricultural sector would not be necessary.

Option 4 - Emissions trading for agriculture in a new ETS 3/AgETS

Another option under discussion is the introduction of a third emissions trading system in the EU. In addition to the agricultural sector, this could cover all or parts of sectors of the current ESR that are not yet subject to a successor regulation. In a separate ETS for agriculture, a sectoral reduction path would be necessary in any case. But even if other emission sources are integrated in an ETS 3/AgETS, agriculture would still be the sector with the highest emissions. As with the option of integrating agriculture in the ETS 2, an emission reduction pathway for agriculture would be indirectly defined. Setting national reduction targets for the agricultural sector would not be necessary.

The following chapter explains some further technical aspects of an ETS for agricultural emissions which would apply both in a separate ETS 3 or if agriculture would be included in the ETS 2. This is intended to better illustrate this completely new policy instrument for the sector.

Key questions:

- How should the EU regulate agriculture emissions in the post-2030 framework?:
  - *Option 1: A target-based approach without pricing*, for example by (a) continuing the ESR, (b) setting sectoral targets for agriculture or (c) establishing a new land-use sector regulation and setting an integrated AFOLU target that merges agriculture and land-use. If Option 1(c), should separate targets for emissions in agriculture, emissions in land use and carbon removals be considered? Should forests rather be excluded, i.e. would an ALU sector be a better alternative?
  - *Option 2: Pricing agricultural emissions via taxes or levies*. How would a fixed price for agricultural emissions, e.g. CH_4 from the digestion of ruminants or N_2O from nitrogen fertilization, be determined and how would periodic adjustments to the price level be made? How would the state revenues from such a system be used?
  - *Option 3: Integrate agriculture emissions into the ETS 2 post-2030.* How would the ETS 2 cap be adjusted to make additional emission allowances available to the agricultural sector?
  - *Option 4: Introduce a new emissions trading system.* Next to agriculture emissions, would such a system also cover other emissions, e.g. all or parts of the sectors in the current ESR that are not yet subject to a successor regulation?

4.2.2 Technical aspects of an ETS for agricultural emissions

The introduction of emissions trading for agriculture is increasingly entering the focus of policy discussions. This could be since the economic approach of the ETS takes better account of the polluter-pays principle than the current climate policy instruments for agriculture. Under the ETS, the number of emission allowances is pre-determined and an allowance price is set that reflects the abatement costs (Isermeyer et al. 2019). These additional costs translate into consumer prices and would steer prices to the benefit of plant-based foods.

At the same time, there are still many open questions about the design of emissions trading for the agricultural sector.

Among the important unanswered questions about the structure of an ETS in this context are:

1. Who should be obliged to participate in this emissions trading system? The farms or should the number of parties involved be reduced and the obligation placed on the “bottlenecks” upstream or downstream in the value chain?
2. What emissions should the system cover? CH_4 and N_2O from livestock, N_2O from soils, CO_2 from peatlands?
3. Should allowances be allocated via auctioning or for free?
4. Should carbon sinks be included in the system?

To answer these questions, much can be learned from the experience of ETS 1. However, the experience gathered with the ETS 1 has also shown that it can take years for an ETS to have the desired effect.

In the following, the essential issues of introducing emissions trading for agriculture are briefly described. Not all questions are answered, but some examples are provided to better convey the issues at hand.

4.2.2.1 Obligated entities

Emissions from agriculture can be included in emissions trading at various points in the value chain for agricultural products: in the upstream chain, in the downstream processing and directly at the agricultural operations. These options are briefly outlined below using examples.

Upstream: Approach based on the example of fertilizer manufacturer/traders

In this approach, the manufacturers/traders of nitrogen mineral fertilizers are obligated to purchase emission allowances. They must purchase allowances on behalf of the farmers for the nitrous oxide emissions which arise from the use of the fertilizer.

The following reactions are to be expected:
The allowance price is added to the product price for nitrogen fertilizer. Agricultural operations will respond by purchasing less and optimizing their nitrogen efficiency through improved fertilizer planning, improved storage and application techniques, intercropping and optimal use or purchase of organic fertilizer. Fertilizer traders could try to bring about a higher price through produce improvement by adding nitrification inhibitors to reduce nitrous oxide emissions, analogous to biodiesel blending by fuel traders in the ETS 2. The additional costs are passed on in the value chain in the form of higher product prices. This affects both animal feed and food commodity prices.

Without import and export protection, goods produced in the EU would be at a competitive disadvantage.

Downstream: Approach based on the example of dairy

In this approach, allowances are needed for the emissions from agriculture at the processing level. Dairy companies have to buy allowances to cover the GHG emissions of the volume of milk purchased. The proof for this is provided by operational data or more differentiated GHG balances of the dairy farms. Dairy companies can cover the extra charge, on the one hand, by staggering the purchase price depending on the GHG balance of the milk and, on the other hand, by passing the remaining costs onto consumers. Another option is for the dairy companies to expand its business base and produce a plant-based substitute product such as oat drink.

The following reactions are to be expected:
If the emission price is sufficiently high, dairy farmers receive the signal to optimize their production with a view to the GHG balance, e.g. by building biogas plants, improved animal health, optimized feed rations or the use of feed additives. If the optimization potential of the technical measures is not sufficient, the target can only be achieved by reducing production. This means that some farms would probably give up milk production and switch to other business models. Remaining producers, on the other hand, would have incentives to reduce their production costs and / or lower specific emissions per production unit by increasing milk yield. This would need to be achieved through a combination of economies of scale, specialization, and use of technical measures. In both cases, the emissions are lower than in the starting situation – and depending on the cap as well the total amount of milk produced.

With appropriate border protection, milk prices would increase for the consumer and, depending on the elasticity of demand (and existence of alternatives), the quantity purchased would decrease. Without border protection, cheaper imports and carbon leakage may occur.

Direct obligation for farms

The third possible starting point of an ETS lies directly with the farms. An important requirement for this system is the establishment of detailed GHG balances for each individual regulated farm. These form the basis for acquiring the necessary emission allowances. The administrative burden of GHG balances on farm level are a possible constraint of the direct obligation of farms. But even with a downstream approach, it must be assumed that the farms will have to compile the necessary data or information. A lot will depend on which farms are included at the outset, how technology and knowledge to facilitate reporting evolves, and what kind of approach is used to gradually increase coverage to other farms. Overall, the adjustment reactions of the farms are the same as outlined in the example for the upstream and downstream obligation.

To date, there is no established ETS for GHGs from agriculture worldwide. However, New Zealand is planning a gradual introduction: Agricultural emissions should be priced there from 2025. The original plan was to price emissions at farm level, but a transitional levy for processors is now being discussed if the pricing system at farm level cannot be implemented in time, because the reporting of GHG emissions on farm level and the planning of mitigation measures and operational adaptation is obviously a very complex task for the farms (NZ 2022). It is important to note that the New Zealand system is expected to cover the emissions from fertilization and those from animal husbandry (digestion and manure management in stables and storage).

4.2.2.2 Scope of covered emissions

The scope of the emissions covered by such an emissions trading system depends on the starting point. With a farm-level approach, up to 100 % of emissions could be captured by corresponding GHG accounting, if no de-minimis threshold for smaller farms is established. In contrast, 13 % of the total emissions would be captured in the upstream chain at the level of fertilizer producers. In the same ETS, however, emissions from livestock farming could also be captured downstream via dairy companies and slaughterhouses, which would cover 68 % of emissions from agriculture. When combined, approx. 80% of emissions would still be integrated into the ETS, while the number of parties involved in the ETS would be significantly smaller. Another option is to include feed suppliers in the upstream ETS.

The following table provides an overview of the emissions that could be captured, depending on which actors are obliged to participate in the ETS. In addition to the relevant emissions and their levels.

Table 4: Overview of emissions covered by the different approaches

Parties subject to obligation	Emission categories	Emissions in 2020 (EU)
Upstream: fertilizer manufacturer/traders	N_2O emissions from the application of mineral fertilizers	50 Mt CO_2 e 13% of total emissions
Upstream: feed suppliers	CH_4 emissions from enteric fermentation	Up to 184 Mt CO_2e 48% of total emissions*
Downstream: dairy farms and slaughterhouses	CH_4 emissions from digestion N_2O and CH_4 emissions from manure management N_2O emissions from nitrogen input on pastures (N_2O emissions from feed production, if applicable) (CO_2, N_2O emissions from fodder production on peatland sites, if applicable).	261 Mt CO_2e 68% of total emissions (excluding animal feed, excluding peatland)
Farm level	All emissions from agricultural sector: 382 Mt CO_2e (Emissions from peatland: 76 Mt COe_2)	Total emissions: 382 Mt CO_2e (without energy use and peatland)
	Emissions from energy could be part of the ETS 2	not available, CRF category 1.A.4c aggregates emissions from energy use in agriculture, forestry and fisheries

Note: *Emissions from manure management are not included, as emission reduction takes place on farm level. For CH_4 emissions from enteric fermentation, it needs to be clarified if only the share of CH_4 emissions which resulted from feed that was sold via the feed suppliers can be charged. Only for this the suppliers can present low-emission alternatives e.g. fodder blended with feed additives
Source: Own representation based on (EEA 2023e) for the year 2020

The share of emissions to be captured should correspond to the effort to capture them. A large share of the emissions can be calculated/estimated using simple modelling approaches.

Farms should only be obligated to participate in emissions trading once they reach a minimum size in order to keep the administrative burden within reasonable limits. The bureaucratic effort of applying for and providing evidence for CAP subsidies is a task that many farms, especially smaller ones, can scarcely afford. The current system, supplemented by an ETS that also obliges the smaller farms, is hardly conceivable against this background.

Bognar et al. 2023 provide some figures: according to this, the largest 20 % of farms would emit 50 % of the total GHG (Grosjean et al. 2016). And small farms with less than 5 ha land account for ca. 64 % of total EU farms (~5.8 million farms of ca. 9 million farms in total), mainly in Member States in southern and eastern Europe. But it is also mentioned that there were intensive livestock units with significant emissions on almost landless farms. For this reason the land criteria should be combined with a criterion for livestock numbers.

Overall, it should be noted that Bognar et al. 2023 provide a good overview of the technical options of an ETS for agriculture.

4.2.2.3 Allocation methodology: auctioning or free allocation

In principle, emission allowances could be allocated via auctioning. In this way, emissions trading provides an incentive to implement GHG reduction measures on farms. With regard to free allocation or auctioning, different designs are conceivable depending on the emission source. The following examples demonstrate this:

- Even with optimised efficient use of nitrogen, N_2O emissions cannot be completely avoided. An allocation of free, non-tradable allowances for a basic value per hectare seems to be one way of not unnecessarily burdening consumer prices. Precisely in view of the affordability of food for all income groups, social compensation of the costs of emissions trading in the agricultural sector is necessary.
- Farms that operate on drained peatland sites constitute an important – only regionally affected – group that deserves special attention in the design process.[17] These sites are to be rewetted as soon as possible. The decision to begin this process does not lie in the hands of the individual farm alone, but is taken on a larger scale. This suggests that, at least in the beginning, allowances for CO_2 emissions from mineralization of organic soils should initially be allocated free of charge and then gradually charged at an increasing price to provide an incentive for rewetting. It is necessary for this to be accompanied by investment aid for alternative income models such as paludiculture or peatland PV and social compensation, as in the approach to the coal phase-out. Early action should be rewarded (Grethe et al. 2021).
- Many GHG reduction measures are associated with costs for farms, which are more significant for small farms, e.g. because higher investments are required per unit produced than for larger ones. The introduction of an ETS would therefore probably lead to an acceleration of structural change towards larger operating entities. A similar effect could be observed with the introduction of phosphate quotas for dairy cattle in the context of phosphate regulation in the Netherlands (Hoste 2017). In order to soften this unintended side-effect, a minimum-amount of free allowances or de-minimis regulation for small farms could be implemented (Bognar et al. 2023).

[17] These emissions fall under the land use sector (LULUCF) in the emissions inventories and not directly under agriculture. The extent to which these emissions would have to be regulated in an ETS for agriculture also depends on whether LULUCF emissions would be incorporated.

4.2.2.4 Use of revenues

The sale of allowances generates additional income. This revenue could be used for accompanying support measures for climate protection and/or climate adaptation, for example for farms that are not obliged to participate in the ETS. The funds could be integrated into the CAP for this purpose, or they could co-finance selected CAP measures. A relevant prerequisite would be to end the climate harmful subsidies included in the CAP (e.g. direct payments for dry peatland cultivation or untargeted coupled livestock subsidies).

Another point is economic performance and social tension among the Member States. Part of the financial resources could be reserved for MS with lower economic performance and/or transnational support in third countries to fund climate protection measures. Comparable mechanisms also exist in ETS 1 and 2.

As an ETS for agriculture leads to an increase in food prices for end consumers, revenues could also go to the Social Climate Fund to be used to compensate financial burden of climate policy – for all citizens as well as for vulnerable farmers within the EU.

4.2.2.5 Inclusion of natural sinks

Alongside the introduction of emissions trading in agriculture, the crediting of sinks or negative emissions to offset emissions is also being discussed. This question is a fundamental one – especially for a sector such as agriculture which will continue to have unavoidable residual emissions. The Commission's draft Carbon Removal Certification Framework (CRCF) (EC 2022c) has already provided the first guidelines in this respect. The discussion about the opportunities and risks of the increased integration of removals is multifaceted and not reflected here in full detail. Since agriculture is able to create natural sinks on its own land, the focus is only on the most important issues raised in connection with natural sinks.

The main arguments in the discussion are:

- Natural carbon sinks are temporary removals and store carbon only for a limited period.[18]
- Additionally, natural carbon sinks have high uncertainties with regard to their permanence. The onset of climate change with weather extremes intensifies these risks (forest fires, extensive damage due to drought and storms, humus depletion).
- Offsetting emissions with natural sinks leads to a delay in emission reduction because natural sinks may be cheaper than measures to curb emissions. In particular, emissions from the combustion of fossil fuels – which can be easily abated by means of energy efficiency and the expansion of renewable energies – should not be offset by an uncertain natural carbon sink.

[18] Any measure that accumulates carbon in soils or vegetation has a maximum uptake capacity that is reached after a few years or decades. CO_2 is only removed from the atmosphere during this build-up phase. Subsequently, the carbon must be protected to secure the mitigation that has taken place in the long term. If climate legislation allows emissions to be offset against this mitigation, it results in a long-term obligation to preserve this natural sink. If the emission source persists – e.g. because it is a source for which no mitigation technology is available – further negative emissions are needed to achieve climate neutrality. If a natural sink continues to be used to offset emissions, another area is needed to build it up.

On the other hand, natural sinks play an important role in countering climate change and should be built up as quickly and as much as possible. This requires strong incentives and support but can also take place outside an offsetting scheme within the ETS.

In a climate-neutral world, unavoidable emissions will have to be offset by negative emissions. In the future, the largest share of unavoidable emissions will come from the agricultural sector. The extent to which the agricultural sector may access the natural sink to offset unavoidable emissions is still an open discussion. In the past, the European Commission proposed the idea of requiring the AFOLU sector to achieve net zero emissions by 2035, as reflected by the EU Commission's idea to merge agriculture and LULUCF into one sector.[19] However, this proposal did not survive the trialogue on the LULUCF Regulation.

To sustain environmental integrity there are several principles for carbon removals. The main points are summarized in Meyer-Ohlendorf (2023):

- Emission reductions first;
- Keeping reductions and removals separate;
- Only removals with permanent storage can fully counteract the warming effect of CO_2 emissions; and
- Removals with temporary carbon storage can only complement emission reductions.

In the context of agriculture, which mainly produces non-CO_2 emissions, these principles need to be adjusted. For example, the lifetime of CH_4 in the atmosphere is much shorter than that of CO_2 leading to other requirements for permanence for CDR.

[19] The extent to which this should also apply to access to the forest sink is debatable. Today this is common practice, due the net accounting of the LULUCF sector: high CO_2 emissions from organic soils (caused by the agricultural sector) are balanced by the forest sink. Given the uncertainty of natural sinks and the possibility of rewetting to reduce emissions, it would be better if the net approach were replaced by separate targets for the sources and sinks of the LULUCF sector.

Key questions:

- Who should be obliged to participate in this emissions trading system? Should the obligation be placed: (a) upstream, for example on the manufacturers/traders of nitrogen mineral fertilizers; (b) downstream at the processing level, for example dairy companies; or (c) directly on farms?
- What emissions should the system cover? CH_4 and N_2O from livestock, N_2O from soils, CO_2 from peatlands?
- What size entities should be obligated to participate in emissions trading? Should a de minimis threshold be introduced to keep the administrative burden within reasonable limits for smaller farms and companies?
- If the costs of such a system are passed on to consumers, what import or export protections would be needed to ensure that agricultural commodities are not put at a competitive disadvantage?
- Should allowances be allocated via auctioning or for free?
- What should the revenues generated by the ETS be used for? How could they be used to support measures for climate protection and/or climate adaptation? Would they be integrated into the CAP?
- How could distributional questions between and within Member States from the system be addressed? Should part of the ETS revenues be reserved for lower-income Member States or go to the Social Climate Fund to be used to help vulnerable farmers and consumers?
- Should carbon sinks be included in the system?

4.2.3 Summary of key arguments

The EU's climate policy approach to date – inclusion of agriculture in the ESR - has not led to significant emission reductions in agriculture and some other covered sectors. GHG reduction targets itself do not incentivize sectoral actors to mitigate GHG emissions. To be effective, they need to be accompanied by a set of policy instruments. Therefore, a weak point of this option is to decide and implement the necessary quantity of measures as well as continuous readjustment.

The other alternatives presented are of economic nature. Option 2, pricing of agricultural emissions at EU level, would probably fail at present because this regulation would not achieve the necessary unanimity. There are attempts to apply qualified majority voting to specific issues within the EU, and environmental and climate protection measures are being discussed to be part of this. But even if these initiatives were to be successful in the medium term, it is unclear whether they would be applied to the pricing of agricultural emissions. The advantage of this option is that pricing could start with the end consumer and have a consumption-directing effect. At the same time, it would not have the feared administrative burden of an emissions trading system.

Key argument in favour of an ETS on agricultural emissions (options 3 and 4) is the price signal to incentivise GHG mitigation. But especially a direct obligation could entail administrative burden and costs for farmers. These could be reduced to some degree by coverage of farms (e.g., implementing a de-minimis threshold) and focussing on the large emission sources. Gathering of emission data could be simplified by using default methods and a harmonized GHG reporting tool. Upstream and downstream obligation will reduce the number of obligated parties and hence the administrative complexity of the system as well as the covered emissions. Nevertheless, the downstream option would also mean an increased effort to record emissions at the farms.

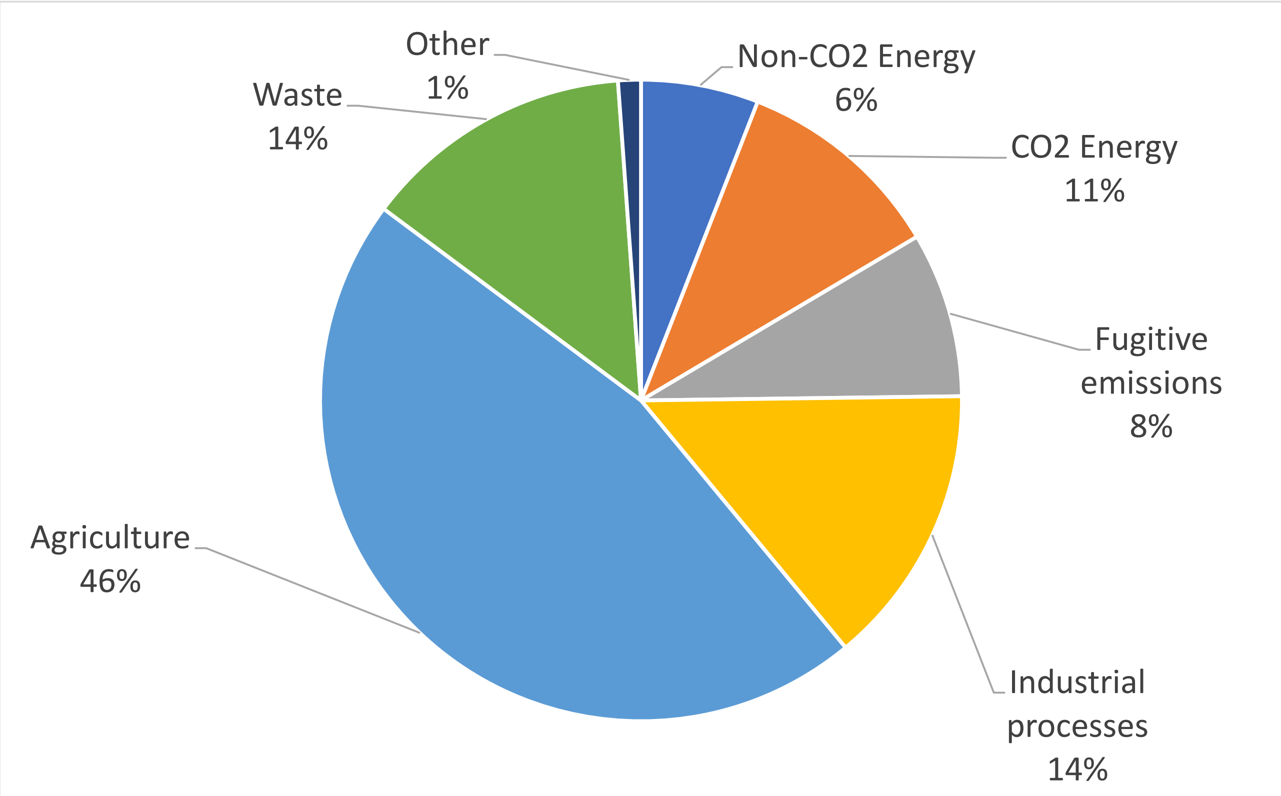
The advantage of integration with other ETS would be the lower system costs (one register, one trading platform, etc.). Another pro-argument is the opportunity for additional revenues generated from the other sectors. But so far, there is only a limited overview of the reduction costs regarding individual farm sizes and types. This makes it difficult to predict the interactions in case of an integration into the ETS 2. An ETS on agricultural emissions would profit from the experience gained with ETS 1 and 2. However, the sector also has many special characteristics, so that a learning phase should be assumed. In addition, the data quality in the ETS 1 and 2 is much higher than in the agriculture sector; inclusion could jeopardise the integrity of these trading schemes.

4.3 Other ESR emissions

Introduction

About 22 % - 23 % of overall GHG emissions excluding aviation and shipping in the EU are not covered by either ETS. Almost half of these emissions (46 %) are due to agriculture, mainly from animal husbandry and fertilizer use. Another 25 % are linked to energy consumption and fugitive emissions from fossil fuels. The remaining “non-ETS” emissions are divided roughly equally between process emissions from industry and waste with about 14 % each.

Figure 19: Share of ESR emissions outside of the ETS 2 in 2019

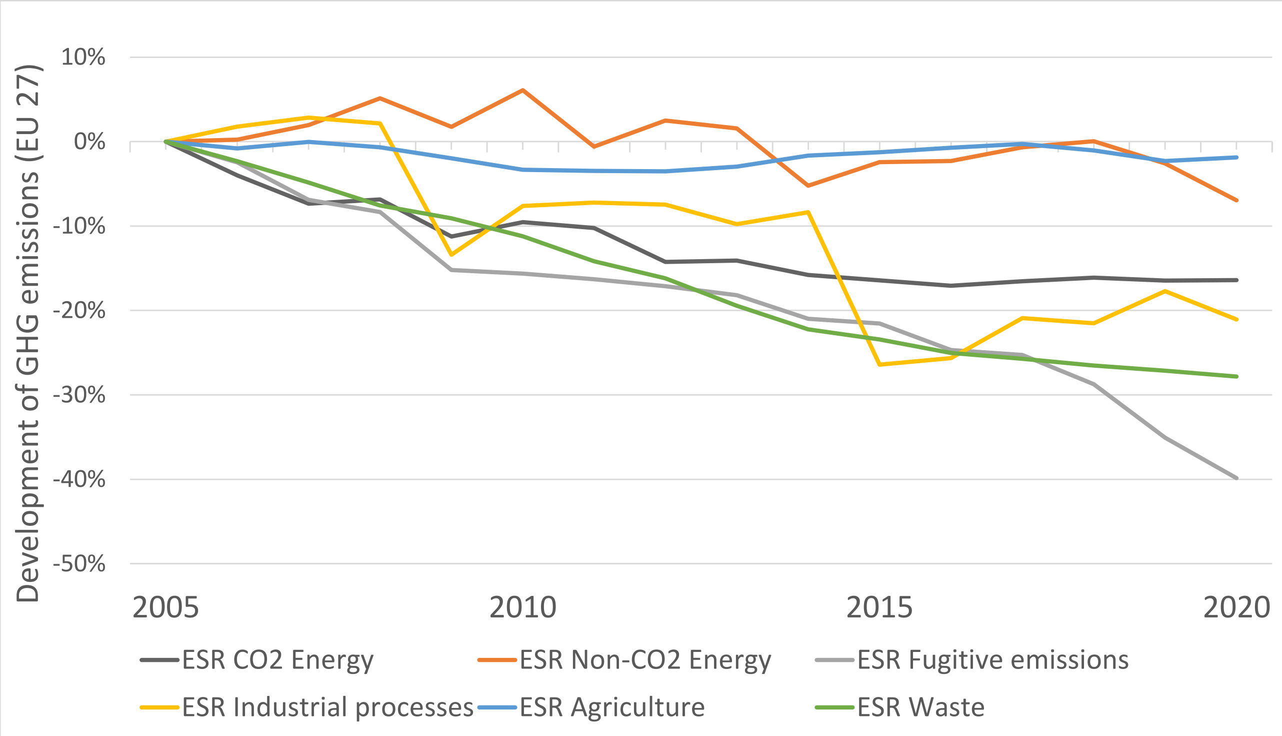


Source: Öko-Institut with data from EEA (2023a)

When looking at relative emission reductions since 2005, agriculture and non-CO_2 emissions from fossil fuel combustion have not really declined in the last 20 years. Emissions from energy-use outside of the ETS (mainly agriculture) declined until 2015 but have stagnated since then. Process emissions decreased in two steps, once during the 2009 economic crisis and again in 2015 and have plateaued afterwards in each case. Only emissions from waste and fugitive emissions from fuel production have declined steadily.

Emissions related to energy use and agriculture are discussed in separate chapters above and not further analysed here.

Figure 20: Development of ESR emissions between 2005 and 2020



Source: Öko-Institut with data from EEA (2023a)

Process emissions

These are emissions from activities outside of the scope of the ETS or from installations below the minimum size thresholds. The largest share of emissions stems from F-Gases outside of the ETS; the only F-Gas included in the ETS is PFC from aluminium production. F-Gas emissions peaked in the year 2014 and have been declining since then again (Table 5). The first iteration of the F-gas regulation (Regulation (EU) No 517/2014 on fluorinated greenhouse gases) was adopted in 2014 and has been amended multiple times since then. A recently adopted proposal by the Commission as part of the FF55 package will require reductions of HFC until 2050 by 98 % compared to 2015, a phase-out of SF_6 in electrical equipment by 2031 and prohibitions for various air-conditioning and heat pump product categories from 2025/2027 based on unit capacity and the global warming potential of the refrigerants used. With this revision there are no major emission sources which are not addressed, i.e. there are no issues to resolve for the 2040 target architecture with regards to F-Gases.

The other process emissions outside the ETS 1 have varied substantially between years, but this might be a data artefact rather than actual changes in activity. These emissions need to be estimated based on MS projections and the reported share of ETS emissions by source category and the data is of mixed quality and not necessarily consistent across MS and years. Despite this, it seems clear that these emissions are relatively small and seem to have declined since 2005. A further assessment of their origin (activity outside the ETS scope or below de-minimis threshold) would be necessary to assess policy options.

Table 5: Process emissions outside of the ETS 1 in Mt CO_2e

	2005	2010	2015	2020
F-Gases	73.8	94.7	96.4	81.2
Other process emissions outside the ETS	68.3	36.6	8.2	31.0

Source: Öko-Institut with data from EEA (2023a) and EEA (2023c)

Waste

The Landfill Directive (1999/31/EC) already regulates the phase-out of biodegradable waste in landfills. Current emissions are a combination of remaining landfilling taking place and remaining biodegradable waste in old landfills. By 2035, only 10 % of municipal waste can still be landfilled. By 2030, all waste that can either be recycled or used energetically may not be landfilled. Waste incineration might be included in the ETS 1 from 2028 onwards (see chapter 3.2).

Key questions:

- What are the key process emissions covered by the ESR, but not covered by the ETS or F-Gas regulation and what policies are best places to address them?
- What additional EU policies next to the Landfill Directive and the potential inclusion of waste incineration in the ETS 1 from 2028 onwards are needed to address non-CO_2 emissions from waste management?
- Can and should any process emissions or emissions from waste management be included in one of the ETS systems?

4.4 Future of the ESR

Depending on the policy choices for the sectors above it might be questionable if the ESR should continue post-2030. If not amended/reintroduced, the ESR will end in 2030. One option would be to discontinue the ESR; in its place new/strengthened sectoral regulation and other policies in the sectors outside of the ETS would need to be introduced and potentially more emissions moved into the existing or potentially new emission trading systems. If the ETS 2 is taken out of the ESR (and potentially extended to all remaining energy-emissions), the scope of the ESR would be greatly reduced. Similar discussions for agriculture might remove the only remaining sector with sizeable emissions. If both are not part of the ESR anymore, its further need would be very questionable.

Duwe et al. (2023) discuss the arguments for/against the ESR post-2030. Their main points are:

- The ESD/ESR has been a strong motivation for taking action at national level; for example, it was a driving force for the German national climate law which in turn shaped the debate about policies and measures to achieve its targets.
- The ESR is weaker than the ETS. First, the compliance cycle is only every five years and even then, only with a delay of three years. Compliance for the period 2021 to 2025 is only

determined in 2028, two years until the end of the ESR. Compliance for 2026-2030 only in 2033 (Gores et al. 2019). Secondly, the obligated entities are national governments. The number of infringement procedures for environmental (and other) reasons in the EU shows that governments do not always take EU law as seriously as they should. In contrast, companies under the ETS are sanctioned clearly and potentially severely; cases of non-compliance have been very limited and often linked to bankruptcy proceedings.

- The strong differentiation between Member States is not tenable already for the 2030 targets but even more so post-2030. With the aim of achieving climate neutrality by 2050, all emission from fossil fuels in all Member States need to be reduced to (almost) zero. Leaving a spread of 40 percentage points in reduction targets between the richest and the poorest Member State is not fit for purpose (see also Oeko-Institut and Agora Energiewende (2020)).

Despite this, the authors argue to keep the ESR due to its importance in the national policy debate. To address its shortcomings, they discuss the option of introducing sectoral targets under the ESR, strengthen the governance regime and complement it with more ambitious sectoral legislation. The governance regime should especially be strengthened with regards to the compliance cycle and a faster and firmer response to expected non-compliance. EU-wide sectoral legislation already is an important driver for GHG emissions reductions from the ESR sectors. Further and more stringent policies would help Member States in achieving their ESR targets.

There are also other reasons to keep the ESR: It is an important safeguard for the ETS 2. Without complimentary policies the CO_2 price in the ETS 2 will be very high (see above). The ESR will force wealthier Member States to take more action to ensure that they meet their ESR targets if they want to avoid the costs of buying AEA. This additional action will help contain the carbon price in the ETS 2 and therefore avoid undue burdens for households in poorer countries. The ESR will also limit total GHG emissions if the ETS 2 exceeds its cap in 2030 due to the allowances issued by the MSR. Some opponents of the ESR argue, that it leads to distortion of competition between Member States (see for example GTD (2023)). While true to a certain extent, the alternative would be to treat all countries identical. The ETS 2 (and potentially a new ETS for agriculture) would then be the main instrument for emission reductions. As discussed above, treating all Member States identical can lead to social imbalances and may put an undue burden on the poorer countries. Lastly, the ESR together with the ETS 2 could become a relevant complementary income stream for the poorest Member States, depending on the design of the system.

If the ESR is kept, there is a need to create more transparency and a price finding mechanism for AEA, the emission quantities under the ESR. Currently, all AEA trade is over the counter, i. e. between governments and without the obligation to publish the price per emission quantity. Private actors are not allowed to participate in AEA trade, in effect there is no real market and large uncertainties on prices both for sellers as well as buyers. In addition, those countries that have a surplus might not be willing to sell their AEA anticipating future demand for these emission quantities. Especially due to the ETS 2 the need and opportunities to trade AEA will increase dramatically (see chapter 4.1.2). Several ideas to enhance transparency and create a price finding mechanism have been proposed already. Oeko-Institut and Agora Energiewende (2020) discuss the following options:

- Establishing an information platform which provides information on the market situation, interested buyer and sellers and some information concerning finished trades. The platform could also go further and include agreed prices for finished trades as well as bids and offers.
- Central auctioning of some AEAs. The revenues could be used to supply an ESR modernisation fund similar to the one in the ETS.

- Obligatory auctioning. All member states would be required to auction a small share of their AEA; they could use the revenues to buy back the same quantity of allowances. Even if all member states would do so, this approach would provide an AEA price which could be used for other deals.
- Inclusion of the private sector through project mechanisms and/or as trading entities (see next section). This approach was very successful for establishing a CO_2-price under the Kyoto Protocol.

The first option, an information platform, would be the weakest of the proposals as it would not include a price finding mechanism. All other options include a real AEA market which would inform all other deals, even if behind closed doors.

Other approaches to national responsibility might be an alternative to the ESR. One option could be based on the national climate neutrality commitments: most Member States have committed themselves to achieve climate neutrality by 2050 at the latest. Economy-wide national targets for 2040 which are in line with the EU's overall 90 % emission reduction and national climate neutrality targets could address some of the reasons for keeping national responsibility for emissions while avoiding some of the issues with the current ESR.

Key questions:

- What is the future of the ESR post-2030 given that (a) the majority of emissions in the ESR will be covered by emissions trading under the ETS 2 from 2027, (b) the ESR will be dominated by agriculture and other non-CO_2 emissions by 2040, and (c) agriculture emissions may be included in a new ETS 3 or merged with LULUCF sectors to form a new A(F)OLU land-use sector?
- Should the ESR continue to exist in its current scope post-2030 in parallel to the EU emissions trading systems in order to serve as a safeguard for the ETS 2 by acting as a driver for national climate action, including complimentary policies that will keep the carbon price in check?
- Could national economy-wide targets for 2040 which are based on national climate-neutrality targets replace the ESR?
- If the ESR is continued, several important questions will need to be clarified: (a) how would national targets be determined?; (b) would a strong differentiation between Member States be possible given all EU Member States must achieve climate-neutrality by 2050?; (c) how can the ESR compliance mechanisms be strengthened?; (d) are additional flexibilities needed given the scale of the emission reductions needed by 2040?
- If the ESR is kept, what new transparency and price finding mechanisms will be needed for AEA trading between Member States?
- If continued, could the ESR realistically serve as an additional source of revenues through AEA sales for lower-income Member States in the period post-2030, or would this no longer be possible?
- If the ESR is not continued in its current form, how should the post-2030 framework look like for the emissions currently covered by the ESR? Should the ETS 2 be taken out of the ESR (and potentially extended to all remaining energy-emissions) and the ESR continued in a much smaller scope dominated by agriculture? Should the ESR be discontinued and replaced by new, strengthened sectoral regulation and other policies in the sectors outside of the ETS, complemented by the integration of additional ESR emissions into EU emissions trading?

5 Negative emissions/CDR

5.1 Introduction

As discussed for the target level and both ETS systems, negative emissions will play an ever-increasing role until 2050. The Commission published a proposal for a voluntary framework for the certification of carbon removals (CRCF) in November 2022 which is currently discussed by Member States and the EU Parliament (EC 2022a). The regulation aims at accelerating the uptake of carbon removals through a set of QU.A.L.ITY criteria (**QU**antification, **A**dditionality, **L**ong-term storage and Sustainabil**ITY**). While this framework might be a first step towards fostering CDR technologies, it will be necessary to go beyond voluntary measures for carbon removals to achieve climate neutrality. The crucial question will be how to create a stronger CDR governance that can deliver the required quantity of removals per year at optimal prices and minimal risks.

The CDR governance framework will depend, inter alia, on these questions:

- **Purpose of the CDR:** Should the CDR mechanism stabilise prices in the ETS, offset remaining emissions, achieve net negative emissions at the European level, finance the development and deployment of BioCCS and DACCS, reduce peak temperature increases, etc.?
- **Relationship with mitigation:** How can it be ensured that CDR does not replace emission reductions? While many reasons exist for mitigation being preferable to removals, it is unclear what constitutes hard to abate emissions which would require CDR. Most or even all emissions could – in theory – be avoided either by changes in consumption patterns (e. g. a dietary change would eliminate emissions from animal husbandry) or by technical measures. The quantity of hard to abate emissions depends therefore on the level of acceptable costs for technical measures and which changes in consumption patterns would be acceptable.

Several parallel CDR frameworks could also be possible, e. g. one that will regulate the inclusion into the ETS with high requirements for permanence and credibility (i. e. DACCS and BECCS). A second mechanism could be directed at governments and the usage of temporary removals. The aim of the latter could be to reduce the maximum global warming to avoid reaching tipping points and bridge the time until more permanent removals are available.

Linked to these questions is the issue of sequencing: which steps need to be taken by when to ensure, that sufficient CDR-quantities are available by the required time?

One of the most detailed outlines of a potential CDR governance structure for the EU was published by Edenhofer et al. (2023). In the following, we summarize some of their main points and proposals:

- **Not all removals are equal:** The problem of non-permanence depends on the CDR technology, the storage duration is longest for BECCS/DACCS (millennia). At the other end are modified patterns in agriculture which might only store carbon for a few years to decades. Forestry related removals are also potentially short-lived (decades to centuries) (Table 6). Carbon stored in products, a third category proposed by the Commission, also allow for temporary storage, but with a wide range of timescales depending on the type of product considered. Any governance scheme needs to take this into account by either giving some kind of removals a discount factor (i.e. multiple tons of CO_2 need to be removed to generate one removal certificate) or by an obligation to continuously replace any release from non-permanent stocks with new (potentially non-permanent) removals.

- **Socially optimal deployment of CDR:** For the society and the climate an abated ton of CO_2 has the same effect as a permanently removed one. A non-permanently removed ton has a lower value, as it only temporarily reduces the social cost of carbon (the damages caused by climate change). At the same time, it incurs a debt for the future as there will be a need to remove the same ton again at some point. If new removal is non-permanent again, this has to be repeated to perpetuity. This raises moral hazard risks, since private market actors may focus on short-term actions (10-30 years) but avoid the perpetual removal liability that their emissions ultimately requires. Furthermore, many non-permanent removals are by their very nature prone to unpredictable large-scale reversals. Despite this, the social optimum includes a share of non-permanent CDR to achieve a certain temperature target. It can be used to avoid or delay very costly abatement measures and increases the size of the available carbon sink.
- **Different CDR technologies need to be scaled up in parallel and as soon as possible:** A uniform carbon price or support scheme would primarily lead to the implementation of the cheapest CDR technologies in the short run. These are linked to land-use activities (afforestation/reforestation, biochar, modified agriculture patterns) and limited by the availability of land (Table 6). In addition, uncertainties about the quantity of stored carbon are generally high. The more costly options such as BECCS and DACCS have a higher global potential, longer permanence, better MRV methodologies and lower land requirements. At the same time, they are still less mature and cannot be deployed on a large scale within a short time-frame. Some of the challenges include the need to build CO_2 transport infrastructure, generate sufficient electricity from renewable sources and ensure a supply of sustainable biomass. It is therefore necessary to ensure that the scale-up of different technologies happens in parallel.

Table 6: Global potentials and costs of relevant CDR technologies

Technology	Potentials [Gt CO_2/yr]	Costs [USD/t CO_2]	Storage duration
Afforestation/reforestation	0–5 - 10	0–- 50	Decades to centuries
BECCS	0.5 -–11	100–- 200	Millenia
Ocean alkalinization	1 - 100	14 - 500	Centuries
Enhanced weathering	2 – 4	50–- 200	Centuries
Biochar	0.3-6.6	30 - 120	Centuries
Modified patterns of agriculture	2 - 5	0 - 100	Years to decades
DACCS	5 - 40	100 - 300	Millennia

Notes: Global potentials, in gigatonnes CO_2 per year (estimate for 2050), and costs, in USD at today's purchasing power per ton of CO_2, of relevant CDR technologies Storage time for different CO_2 removal technologies is given by the half-life.
Source: Edenhofer et al. (2023)

The authors argue that the governance structure needs to be able to deliver the following four tasks:

1. **Management of the cap:** The governance framework must ensure that, despite significant uncertainties about the development of climate mitigation measures and carbon removal technologies, the allocated role of abatement and removals helps support the achievement of the EU's climate goals, including the politically set ETS cap. This could be achieved by different means, for example by issuing additional ETS allowances for the removal of CO_2 through BECCS and DACCS or by reverse auctions of quantities of removals by technology.
2. **Innovation and diffusion**: Additional research, development and technology diffusion policies are needed to help scale carbon removal technologies to the levels needed. Currently, there is very limited practical experience with many of the CDR technologies considered promising options for future removals. If not addressed, a lack of technical expertise, access to funding, public acceptance, uncertain regulatory frameworks and other barriers might hamper the deployment of CDR technologies.
3. **Certification:** Carbon removal will need a robust certification framework. This will require a thorough assessment of CDR technologies with respect to their additionality and permanence, determining the discount factor for non-permanent removals and harmonisation of rules and standards across public and private bodies.
4. **Liability management:** The governance framework will need to address the liability issues surrounding non-permanent removals. Non-permanent removals are similar to a debt and need to be replaced in the future, potentially multiple times if replaced by more non-permanent removals. It needs to be ensured that this happens even if the company that originally removed the CO_2 or bought the corresponding allowances does not exist anymore or is unable to finance the required replacement.

To deliver these tasks, the authors propose three entities: a) A *European Carbon Central Bank* (ECCB) would be responsible for the management of the cap and liability. It would need to be backed by sufficient resources to be able to deliver its functions. b) A *Green Leap Innovation Authority* (GLIA) that would be in charge of RD&D and diffusion and c) a *Carbon Removal Certification Authority* (CRCA) that would be responsible for all tasks around certification and evaluation of CDR technologies.

5.2 Issues to resolve for 2040 target/ architecture

This discussion raises the following key questions in the context of the 2040 climate target debate:

Net emission target or separate targets for emissions and removals

A wide range of possible (negative) emission targets is possible. One extreme would be to only have one net target covering all emissions and removals without any further differentiation. All emissions and permissible CDR options would be treated as equal. At the other end of the spectrum, it would be possible to set detailed emission and removal targets by type of CDR or even emission control regime. The EU's 2030 target consists of a net emission target and a separate removal target for LULUCF. The idea behind the single target is cost-efficiency: the cheapest option could be implemented to achieve the net target. At the same time, there are strong reasons against this approach (for example, see CMW (2024)): Mitigation should come before offsetting due to risks around permanence, carbon leakage and uncertainties about removed quantities. Looking beyond 2050 when the EU intends to become net negative, any remaining emissions will make achieving this even more difficult. An advantage of separate targets by different CDR technology would be to ensure a scale up of options which would not be developed otherwise. BECCS and DACCS will play a key role in achieving net-negative emissions but are expensive compared to some other options. At the same time, it will be necessary to start developing such projects early on to ensure sufficient removal capacities in the second half of the century. Other options might have high co-benefits e.g. on biodiversity justifying higher cost. Dedicated policies and measures fostering some CDR technologies despite higher costs would be an alternative to setting CDR-specific targets (see below).

Type and purpose of different CDR technologies

Another key question will be the type of CDR technologies which can be used to achieve the targets. Both the question of permanence but also the certainty of removed quantities is very distinct between different technologies. Uncertainties are especially high in land-use sectors which also have the shortest storage durations. The impact of offsetting emissions with such removals would be very different than the impact of allowing BECCS/DACCS. While it would be better to only use high-quality offsets, it might be necessary to also include lower-quality removals to reduce net emissions fast enough. Care needs therefore be taken with respect to the purpose of removal quantities. In the ETS 1 and ETS 2, which have strong caps and strong MRV requirements, a higher standard could be required than for national or separate removal targets outside of the ETS. One added benefit of limiting the ETS to BECCS and DACCS only would be that these technologies would be directly incentivised. Despite this, it might be necessary to support the deployment of these two options in addition to the inclusion into the ETS 1/2. The case would be different for an ETS 3 in the agriculture sector.

Lower-quality but potentially cheaper or more readily available options could play a role in achieving national targets and achieving net-negative emissions. At national level, the question of liability and renewal of expired removals might be easier to solve. Especially if such removals are not used to reduce mitigation ambition, they might play a crucial role in reducing the peak temperature and associated risks of reaching tipping points before global cooling can be achieved.

Governance and financing of CDR

The third set of questions look at achieving and ensuring carbon dioxide removals. Issues to resolve include sequencing of CDR (i.e., which removals will be introduced when), the financing and the overall governance structure. These issues are closely linked to the type of CDR technologies and purposes discussed above. For example, if the aim is to achieve a relevant supply of removals for use in the ETS by 2040 it will be important to start developing such projects in time. At the same time, there are already revenue streams and funds in both ETS which might be used to finance first projects. Other financing options include other EU funds, carbon contracts for difference (CCfDs), debt financing or relying on the private sector. With regards to sequencing it could be possible to allow the use of removals which were generated before the inclusion of BECCS/DACCS into the ETS.

The governance questions revolve amongst others around certification and liability discussed above. Is it necessary to include an intermediary such as a ECCB or could CDR be directly integrated? Will there be discount factors to achieve fungibility between different types of CDR units? Should different types of units be fungible?

Key questions:

- Carbon Dioxide Removals will play an important role in delivering climate-neutrality by 2050 and net-negative emissions thereafter, but what is the scale of CDR already needed in a 2035 and 2040 perspective?
- What is the appropriate sequencing to enable the scaling up of CDR in time to achieve climate-neutrality? Which steps need to be taken by when to ensure that sufficient CDR-quantities are available by the required time?
- How can the EU CDR governance be strengthened to deliver the required quantity of removals per year at optimal prices and minimal risks?
- What would be the main purpose of such a CDR mechanism: to stabilise prices in the ETS, offset remaining emissions, achieve net negative emissions at the European level, finance the development and deployment of BECCS and DACCS, reduce peak temperature increases, …?
- How can it be ensured that the scaling of CDR does not replace or distract from the need to achieve emission reductions?
- Should there be one central CDR framework or several working in parallel? For example, could technical removals (i.e. DACCS and BECCS) in part be integrated into the ETS while having a separate mechanism directed at governments to govern the scaling up of temporary natural removals?
- Should there be only one net emission target covering all emissions and removals without any further differentiation, or should there be differentiated emission and removal targets?
- Should all CDR options be treated as equal or should there be a stronger differentiation by type of CDR, for example via technology specific CDR targets or dedicated policies and measures fostering specific promising but immature CDR technologies (e.g. DACCS)?
- Should CDR be integrated into the ETS 1? If so, from which year (e.g. after 2035) and which CDR technologies should be eligible (e.g. BECCS/DACCS)? What additional support policies would be needed to enable the scaling up of CDR?
- With regards to certification and liability, is it necessary to include an intermediary such as a European Carbon Central Bank between the ETS 1 and CDR projects or should CDR project developers be able to directly participate in the market? Will there be discount factors to achieve fungibility between different types of CDR units? Should different types of units be fungible?
- How can the scaling of CDR be financed and what role can EU funds and instruments play?

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