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Novel carbon dioxide removals techniques must be integrated into the European Union's climate policies

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Given the escalating climate crisis, the task of integrating novel carbon dioxide removals into the European Union's climate policy is urgent and long overdue. Here, we argue that there is a window of opportunity for responding now, and put forward a solution.

In comparison to its emissions reductions policy, the European Union's (EU) policy for achieving carbon dioxide (CO₂) removals is underdeveloped¹. Only in forestry and land use management does current EU law allow its Member States to use removals to comply with their climate policy commitments. This excludes the potential role that novel removals could play for effectively and efficiently addressing climate policy objectives². Novel removals with significant European potential include bioenergy with carbon capture and storage, biochar, enhanced weathering, marine removal options like alkalinity enhancement, and direct air carbon capture and storage³.

Emissions reductions are crucial to mitigating climate change. However, in the past decade, the world community's failure to reduce emissions at a sufficient speed to avoid dangerous climate change has become obvious⁴. This reality acutely necessitates the development of innovative sets of policies to spur the deployment of novel CO₂ removals, an urgency that is further underlined by the long lead time for many novel removal methods. Disregarding the potential of novel removals is incommensurate with the scale of the challenge of achieving EU's commitment to reach net-zero greenhouse gas emissions by 2050.

We argue that the current policy framework neither provides Union-wide economic incentives for novel CO₂ removals, nor does it encourage EU Member States to develop national policy incentives. Our proposed solutions includes incentivizing removals through a conditional integration into the EU Emissions Trading System (ETS), expanding the portfolio of removal methods in the Land-Use, Land-Use Change and Forestry (LULUCF) Regulation, and to manage anticipations regarding which residual emissions that need to be counterbalanced by removals.

Ambitious targets for carbon dioxide removal in the EU

Novel CO₂ removals are essential for the trustworthiness of the EU's ability to achieve its climate policy objectives. Limiting removals to forestry and other land-use activities cannot supply enough net removals to meet the required demand and prevents the cost-efficient achievement of

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ambitious economy-wide net emissions reductions targets⁵. Limiting CO₂ removals to those included under the LULUCF Regulation cannot, for example, allow for a negative cap in the EU ETS since LULUCF removals are not allowed to generate credits within the ETS⁶. The European Commission’s own modeling of scenarios to achieve net-zero greenhouse gas emissions by 2050⁷ acknowledges this by projecting a contribution from bioenergy with carbon capture and direct air carbon capture in the range of 207–486 MtCO₂ in 2050 for utilization and for storage; geological carbon storage is projected in the range of 80–298 MtCO₂ by 2050. One of the scenarios even includes a net-negative cap of –50 MtCO₂ in the EU ETS. Forestry and land-use removals are projected to contribute between –317 to –471 MtCO₂, a substantial but not sufficient contribution to reaching the 2050 objective⁷. Moreover, many novel removals provide CO₂ storage with higher durability than forests and enhanced soil organic carbon stocks, an added value in the quest to achieve net-zero and net-negative greenhouse gas emissions⁸.

The most recent development in EU climate policy, in terms of setting headline targets, is the Climate Law, which includes a new long-term objective to reach net-zero greenhouse gas emissions by 2050, an updated milestone target for 2030, and a requirement that the European Commission should propose “a Union intermediate climate target for 2040” (§30) within the first half of 2024⁹. The new 2030 target not only increased the ambition from –40% to –55% below 1990 levels, but also moved the Union from a focus on gross to net emissions reductions. The 2030 target and long-term objective are, in turn, supported by three climate policy pillars, where the policy process specifying the milestone (2030) target is referred to as making the EU “Fit For 55.” In addition,

several partially overlapping instruments are designed to facilitate the delivery of objectives within each climate policy pillar, portrayed schematically in Fig. 1.

Proposed policy initiatives on carbon dioxide removal in the EU

The European Commission’s Directorate-General for Climate Action has presented a legal proposal for a certification framework for CO₂ removals, which has initiated an ongoing legislative process on how the effect of different removal methods could be measured and made comparable. In its proposal, the European Commission indicates that the use of the certification scheme should be “voluntary” (§3) and “should go beyond statutory requirements” (§11), including for use in “the compilation of national and corporate greenhouse gas inventories” and “the exchange of verified CO₂ removal units through voluntary carbon offsetting markets” (§21)¹⁰. However, the voluntary removal credits market is immature and needs regulatory leverage to guarantee quality and generate trust, which are fundamental components for the market to scale¹¹.

The recently proposed certification scheme is helpful in this regard, in that it could provide standards and guardrails against removal credits of low quality. However, the voluntary market is unlikely to spur novel removals on a substantial scale in Europe¹². On top of removals spurred by the voluntary market, additional voluntary contributions by Member States are also conceivable. The European Commission highlights that such contributions would have to be above their existing legal obligations under the LULUCF Regulation¹⁰. Given the already daunting task of delivering net removals of 310 MtCO₂ by 2030, such additional

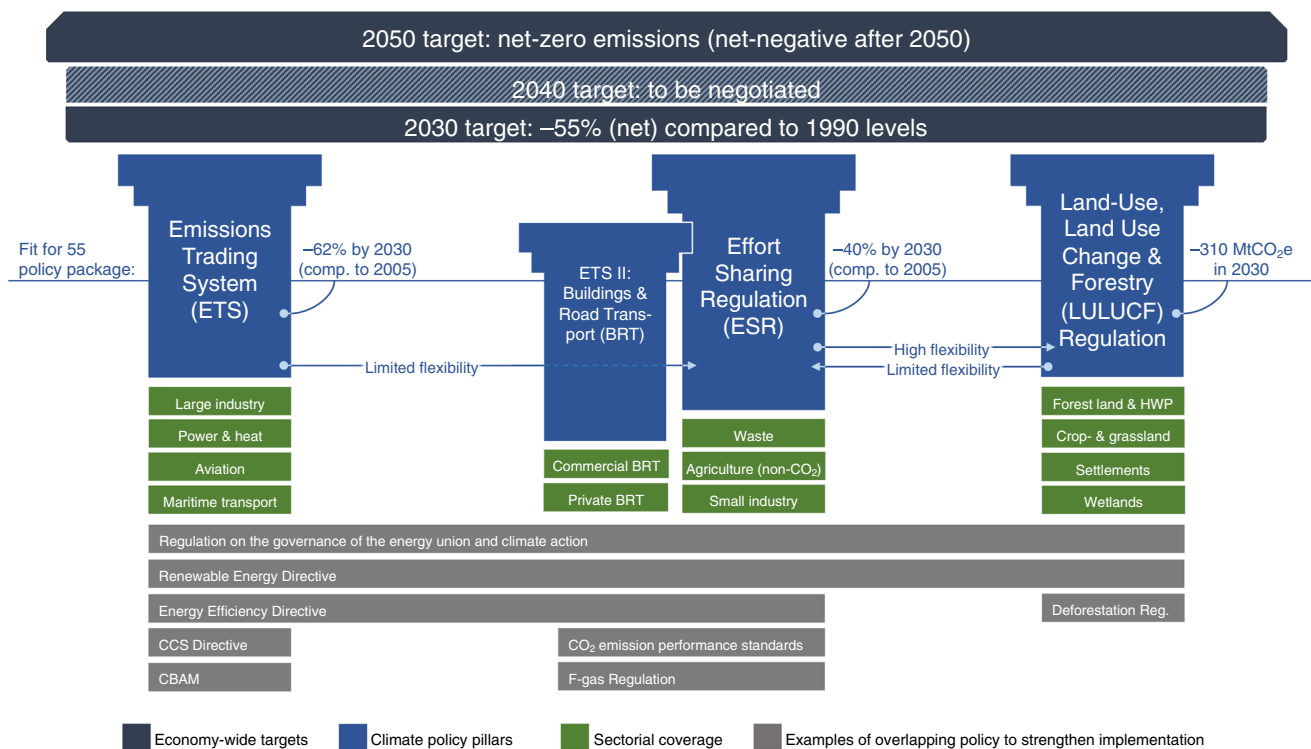


Fig. 1 The EU climate policy framework. The figure illustrates the result of the Fit for 55 policy reform package, i.e., the reforms of the legal acts underpinning the milestone target to reduce net emissions by 55 percent by 2030 compared to 1990 levels. Note that the pillar structure in force until 2030 might be reformed for the period beyond 2030. Regarding the LULUCF Regulations, note that the EU Member States are obliged, in aggregate, to deliver net removals of 310 MtCO_{2e} of which only 225 MtCO_{2e} can be used to achieve the 2030 target. Wetlands will be covered by the LULUCF Regulation from 2026 onwards. Regarding the ESR, the Buildings and Road Transport (BRT) are covered by the regulation. The new Emissions Trading System (ETS II) will be gradually introduced in the ESR to cover emissions from Commercial BRT by 2027 onwards and Private BRT from 2029 onwards. HWP refers to Harvested Wood Products, CCS to Carbon Capture and Storage, and CBAM to the Carbon Boarder Adjustment Mechanism.

voluntary contributions seem unlikely to be substantial. The keyword here is scale. Since we are of the view that the voluntary market as well as voluntary contributions by Member States making contributions above and beyond existing EU targets are likely to be relatively limited, the only other route that we can imagine for novel removals to reach a significant scale in the EU is to firmly link it to commitments, the regulated compliance market, and other economic incentives.

While addressing certification is applaudable, it could also be viewed as premature if integration of CO₂ removal into the existing and emerging climate policy framework is not addressed simultaneously. The proposal has initiated debate on removal methodologies without a clear picture of how resulting certificates could be used. There is a risk that starting with more technical questions—e.g., measurement standards—will preempt the more political negotiations.

An opportunity to address novel carbon dioxide removals

The question of how to go about integrating CO₂ removals into the Union's climate policy is well overdue. At least two opportunities for integrating novel CO₂ removals into EU climate policy have been missed. First, novel removals should ideally have been addressed in negotiations on the European Climate Law. The Law moved the EU from a long-term emissions reductions goal, specified in strategy, to a net-zero commitment—and net-negative thereafter—inscribed in law. CO₂ removal is not an excuse to avoid emissions reductions. On the contrary, scaling removals presents an additional challenge, without which net emissions reductions targets cannot be achieved. Even so, the Law was adopted without deliberating the potential role of novel removal methods. The second missed opportunity was in the Fit For 55 negotiations, which could have integrated novel removals into the substantial reform of the legal acts underpinning the Climate Law.

Fortunately, a new chapter in the development of EU climate policy is fast approaching. Scheduled to commence in 2024, the negotiations on the 2040 target offer a new window of opportunity to integrate novel removals. Integration of novel removals is an already well overdue and crucially important regulatory condition for CO₂ removal as a building block of the net-zero-compatible climate policy framework. It should, therefore be a centerpiece of the negotiations on the 2040 target.

Recommendations for the integration of novel removals into EU climate policy

1. Situate CO₂ removals with highly durable storage in the EU ETS. The Directive on the Geological Storage of Carbon Dioxide¹³ (the CCS Directive) already links the EU ETS to storage-related liabilities, for example through a requirement to surrender EU ETS allowances corresponding to physical CO₂ leakage from storage sites. As such, the ETS is well-prepared for incentivizing removals associated with highly durable geological storage, including bioenergy with carbon capture and storage and direct air carbon capture and storage¹⁴.

The biggest problem with fungibility between removals and emissions reductions in the EU ETS arises if credits can be generated through cheap CO₂ removal methods associated with large measurement and storage-related uncertainties. Some forms of CO₂ removals from forestry and agriculture are potential candidates for such low-price-high-uncertainty credits. An unconditional supply of cheap credits could undermine the carbon price on the allowance market, as historical experience has shown: A high number of credits generated under the Kyoto Protocol—about 10% of the cap

in the second trading phase, 2008 to 2012—were used to offset emissions in the EU ETS¹⁵, which likely contributed to lowering the allowance price¹⁶.

This risk can, however, be mitigated through a conditional integration of CO₂ removal into the ETS, achieved through the early procurement of removals that generate CO₂ removal credits. The credits can be banked and supplied to the allowance market with a delay. We have previously outlined such an argument and referred to the necessary institutional mandate as a European Carbon Central Bank¹⁷. Removal methods eligible to generate credits within the EU ETS should be limited to bioenergy with carbon capture and storage and direct air carbon capture and storage. These removal methods are associated both with storage on millennial timescales³ and with well-regulated obligations and responsibilities¹³.

A conditional integration would facilitate early learning in the removals sector while also maintaining incentives for learning in the abatement sector, supplying removal credits only when necessary to stabilize prices as the system is otherwise likely to start experiencing liquidity-related problems. Problems with liquidity would emerge if abatement options are constrained while the emissions cap continues to decline on annual basis. In such a situation, which is very likely to occur well before 2040 with the current rate of decline in the cap, demand for allowances would far outweigh supply, resulting in a cost increase that risks undermining the political support for the trading system within the EU (Fig. 2). Moreover, there is a need to accommodate a net-negative cap in the longer term.

2. Expand the removals portfolio in the LULUCF Regulation. The LULUCF Regulation already acknowledges several removal methods, including activities such as changed age structure in forests, re- and afforestation, and the use of harvested wood products. Additional removal methods like enhanced weathering, biochar, and coastal biomass expansion should be considered for inclusion in the portfolio. The key rationale underpinning our proposal is: Further extending the scope of CO₂ removals allows for an even more ambitious and active climate policy. A feature of the LULUCF Regulation and the EU Climate Law that often passes unnoticed is that only 225 MtCO_{2e} of the aggregate commitment to 310 MtCO_{2e} in net removals can be used for achieving the Union-wide 2030 target. This means that the EU already aims at overachieving its 2030 target by two percentage points (i.e., to achieve -57% net reductions) with the help of established removal methods. The inclusion of further removal options would pave the way for a higher ambition in LULUCF net removals by 2040. However, we also acknowledge the many challenges associated with expanding the CO₂ removal portfolio. The different removal methods that are currently not acknowledged in the LULUCF Regulation have very different characteristics. Measurement and verification is a case in point: The lack of approved standards for measuring and monitoring such removals constitutes a key challenge for including them in the LULUCF Regulation. In this regard, the work of the European Commission's expert group on CO₂ removals—in part tasked with developing methodologies to operationalize the framework for removal certificates—is likely to be useful. The European Commission has underlined the importance of making certification methodologies consistent with the LULUCF Regulation¹⁰. Such an approach is applaudable since, if this is achieved, the step from voluntary application to making the framework an integral component in achieving LULUCF commitments is not implausible.

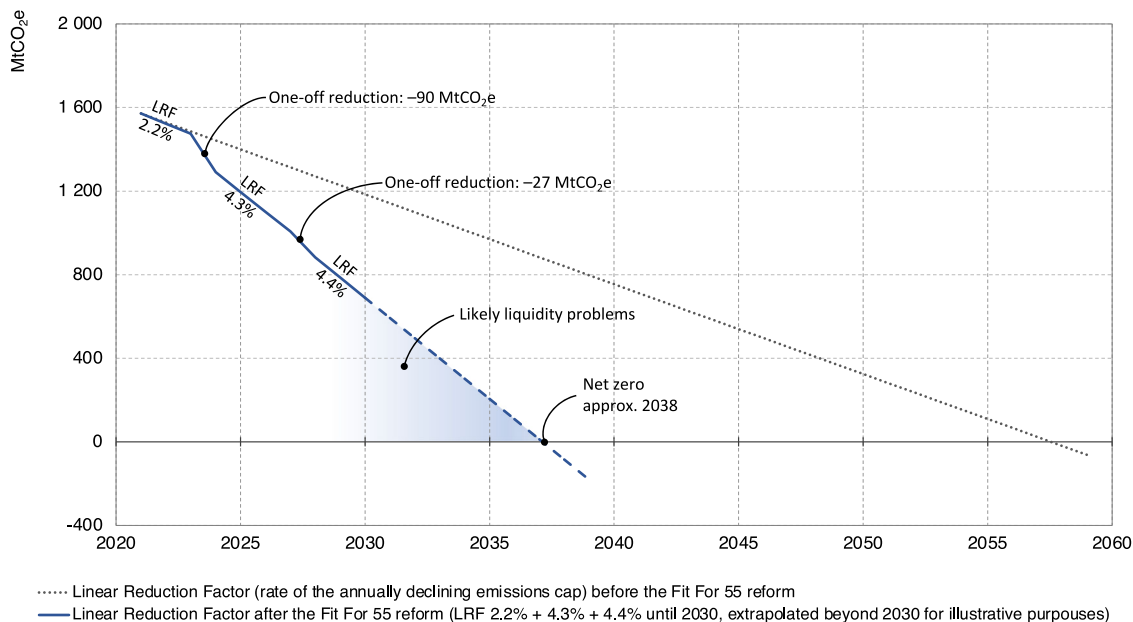


Fig. 2 The reformed cap in the EU Emissions Trading System. Illustration of the effect of the Fit-for-55 policy reform package on the annually decreasing emissions in the ETS. The current policy regulates the linear reduction of the cap until 2030, the effects beyond 2030 are based on extrapolation of the linear reduction factor (LRF) in force for 2030, which may be subject to change after the adoption an economy-wide milestone target for 2040. Liquidity problems would arise if the market experiences a severe shortage of emissions allowances, i.e., when the emissions from installations covered by the trading system far outweigh the supply of allowance. Unless policy reform addresses the issue, liquidity problems are likely to occur in wake of the quick decline in the cap. The figure does not account for the introduction of shipping in the EU ETS from 2024 onwards (gradual integration starting with a coverage of 40% of emissions to include 100% by 2027), nor does it reflect the potential effects of the Market Stability Reserve or the possibility of banking allowances for future use.

3. Reserve removals for counterbalancing hard-to-abate emissions in the Effort Sharing Regulation. A share of European greenhouse gas emissions would be very expensive to abate in the foreseeable future. Recent research has highlighted the need to start specifying what would be considered too expensive or unavoidable to abate and therefore termed 'residual emissions'¹⁸. In turn, there is a fear that multiple sectors will try to claim that their emissions qualify as residual^{19,20}. A discussion on the specification of the residual level is necessary within the EU, and removals need to be scaled up and reserved for counterbalancing this residual.

The ESR covers greenhouse gas emissions that we envisage as candidates for valid claims to be residual. Once the new ETS has become fully operational (see Fig. 1), it will govern emissions in the building and road transport sectors. Member States will also have to address the remaining part of the ESR that will almost exclusively comprise methane and nitrous oxide emissions from waste treatment and agriculture, in addition to fluorinated gases. Diffuse emissions from the waste and agriculture sectors are some of the hardest to abate, making them candidates for claiming a large share of the residual.

The aggregate removal obligation specified in the LULUCF Regulation must be closely coordinated with a negotiated acceptable amount of residual emissions in the ESR and reserved to counterbalance this residual in order to achieve the Union-wide targets. The easiest way to reserve a share of LULUCF net removals to counterbalance residual ESR emissions goes through the specification of the Union's LULUCF net goal and the Member States' LULUCF commitments. If an accepted residual is identified in the ESR, a more ambitious LULUCF target could be set to counterbalance this residual. Our second recommendation—to expand the LULUCF Regulation to include a bigger portfolio of CO₂

removal methods—would help to achieve the necessary increase in LULUCF ambition to counterbalance an ESR residual.

The current flexibility between the ESR and LULUCF Regulation (Fig. 1) is unproblematic in this regard. If a Member State fails to comply with its net removal obligation under the LULUCF Regulation, the same Member State's emissions entitlements under the ESR decline by an amount equal to the underachievement in the LULUCF sector. The flexibility to use annual emissions allocations under the ESR to achieve LULUCF obligations is unlimited. The currently allowed flexibility is, however, for the most part unidirectional; the use of overachievements in the LULUCF sector for offsetting underachievement in the ESR, is constrained and should continue to be so to avoid undermining the abatement pressure in the ESR. The aggregate flexibility to use LULUCF credits to achieve ESR commitments is capped at 262.2 MtCO₂e in the period 2021 to 2030, of which half can be used in 2021–2025 and the other half in 2026–2030. This flexibility is distributed among Member States based on the share of emissions from agriculture, acknowledging the lower abatement potential of agriculture emissions covered by the ESR. As a result, the flexibility ranges from 26.8 million LULUCF credits for Ireland to 0.03 million credits for Malta.

At the same time, with continued Union-wide emissions reductions, the importance of including measures for price management of emissions allowances in the EU ETS increases (see Fig. 2). While the Fit-for-55 reform of the EU ETS resulted in a much lower price trigger for the release of additional allowances than was the case before the reform, any additional supply of allowances translates into increased emissions in the EU as a whole, unless compensated for by emissions reductions in the ESR. This, in turn, becomes increasingly difficult since the sectors covered by the ESR already face ambitious targets. Accordingly, any approach to manage the allowance price for a

smooth transition to Union-wide net-zero greenhouse gas emissions requires the conditional inclusion of removal credits in the EU ETS, to keep the net emissions unchanged.

Conclusions

To summarize our proposal, we argue for:

1. Conditional integration of CO₂ removals with storage on millennial timescales into the EU ETS, in order to initiate early learning in the removals sector and to enable price management if and when the trading system starts to experience liquidity-problems.
2. Expansion of the portfolio of removal methods included in the LULUCF Regulation in order to incentivize a broader set of methods and enable higher ambition.
3. Reservation of removals from the LULUCF Regulation for counterbalancing truly hard-to-abate emissions in the Effort Sharing Regulation, which involves a discussion about what counts as the Union's anticipated legitimate residual emissions.

We are convinced that acting in accordance with these three points would amount to a radical breakthrough in EU carbon dioxide removal policy. It would spur a palette of removal methods and position the Union as a global role model for CO₂ removal action, leading the way into a future in which CO₂ removals have a chance to correspond to envisioned global net-zero emissions targets.

Data availability

All policy referred to in the manuscript can be accessed through <https://eur-lex.europa.eu>.

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Author contributions

M.F.: conceptualization, writing original draft and review and editing, visualization; F.S.: writing original draft and review and editing; L.L., K.M., M.B., W.R., and A.H.: review and editing.

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