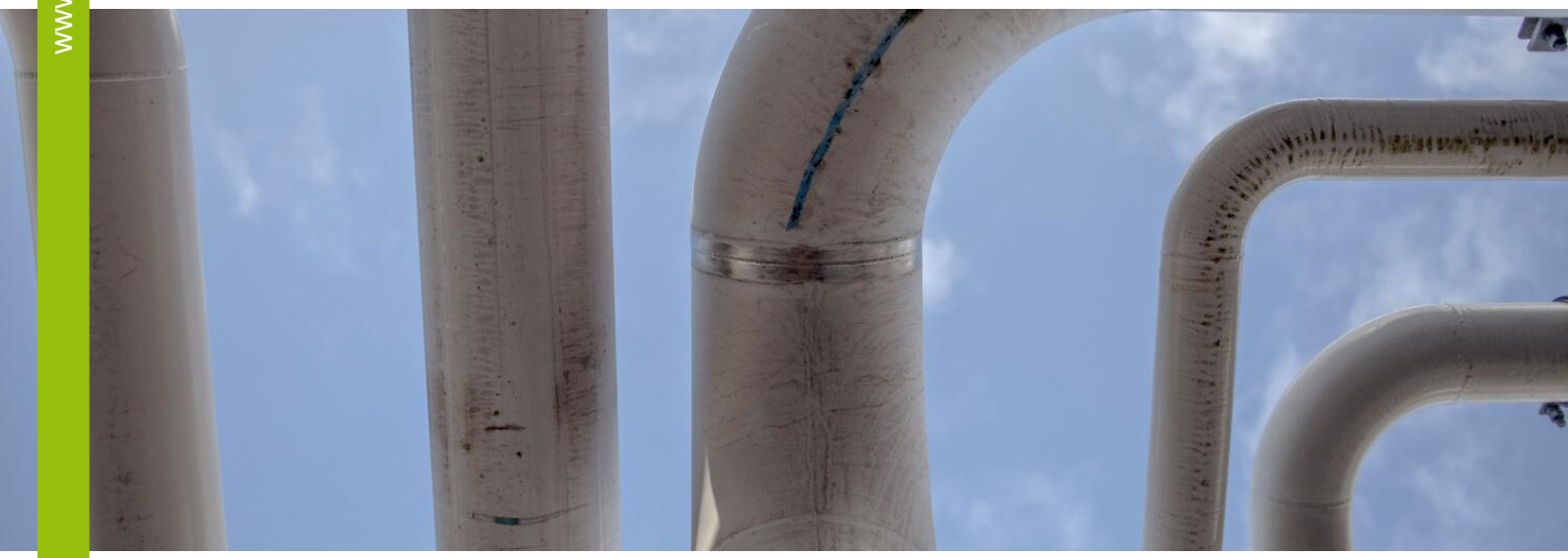
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Residual Emissions in the EU-ETS1 Sectors

Developing an estimate of residual emissions in 2040 and 2050

// Christoph Heinemann | Dr. Roman Mendelevitch | Moritz Vogel | Lukas Emele | Hannah Bachmann | Dr. Felix Mayer | Dr. Ralph Harthan | Nora Wissner | Jakob Graichen

// Study funded by Carbon Market Watch

// November 2026

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Part I: Overview of key results

1 Scope of study

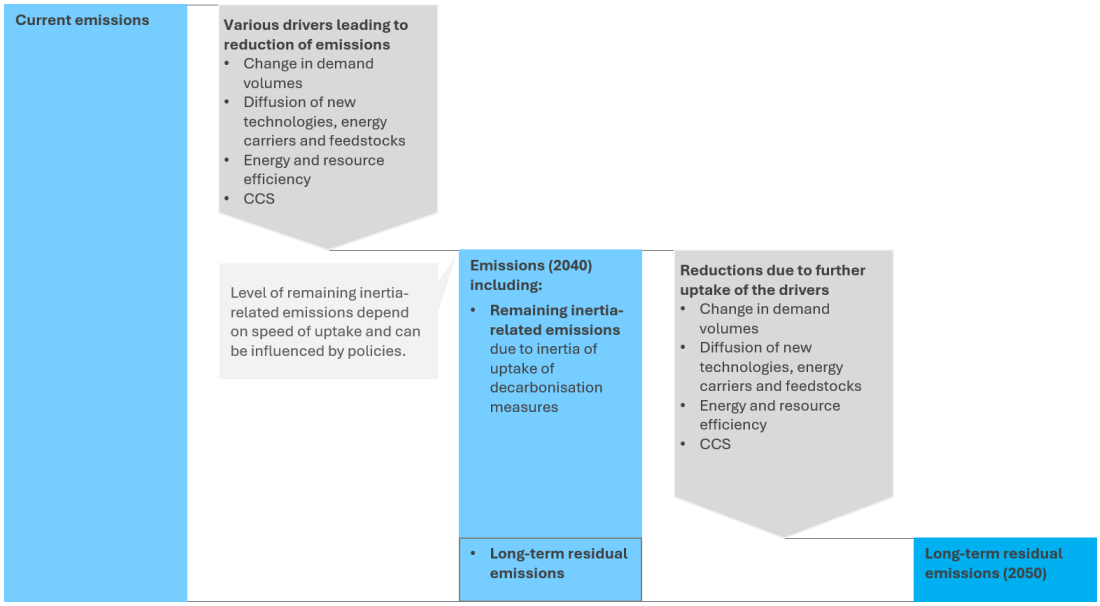
The goal of this study is to support the debate on residual emissions in the industries and sectors covered by EU-ETS1. The main research question is: **What could be the scale of residual emissions consistent with technological abatement potentials and ambitious decarbonisation pathways?**

We performed individual research on possible emissions reduction pathways for the most relevant industry sectors for 2040 and 2050 as well as waste incineration, maritime transport, and aviation, and employed a tractable top-down approach for the remaining emissions covered by EU-ETS1. The study does not perform own modelling or optimisation of all sectors. The resulting range of scenario-dependent emissions in 2040 and 2050 is an estimate based on bottom-up research on emissions per sector. Sector-specific residual emissions are estimated based on literature and expert knowledge and can act as a starting point for discussions and further sector-specific input from experts.

The term "residual emissions" is not defined consistently. To differentiate between emissions that remain during the transformation process of the economy due to slow uptake and emissions that are expected to remain in the long term due to technical reasons this study uses two terms (Figure 1-1):

- **Remaining inertia-related emissions**: Taking in account current technology readiness levels (TRL) and planned infrastructures, these are emissions that will be further reduced but remain at a certain point in time due to inertia in the uptake of abatement technologies and ramp-up of infrastructures. In our study these remaining inertia-related emissions are reported for the year 2040. Their amount can be reduced by ambitious target-setting, and increased efforts in technology and infrastructure roll-out.
- **Long-term residual emissions**: Emissions that are not likely to be further reduced based on today's technology and infrastructure outlook. These are remaining process-related emissions either with no or with low TRL abatement technologies or from small-scale installations, where carbon capture cannot be employed at scale. We assume in this study that for most sectors, the level of long-term residual emissions can be reached by 2050.

Figure 1-1: Definition of residual emissions



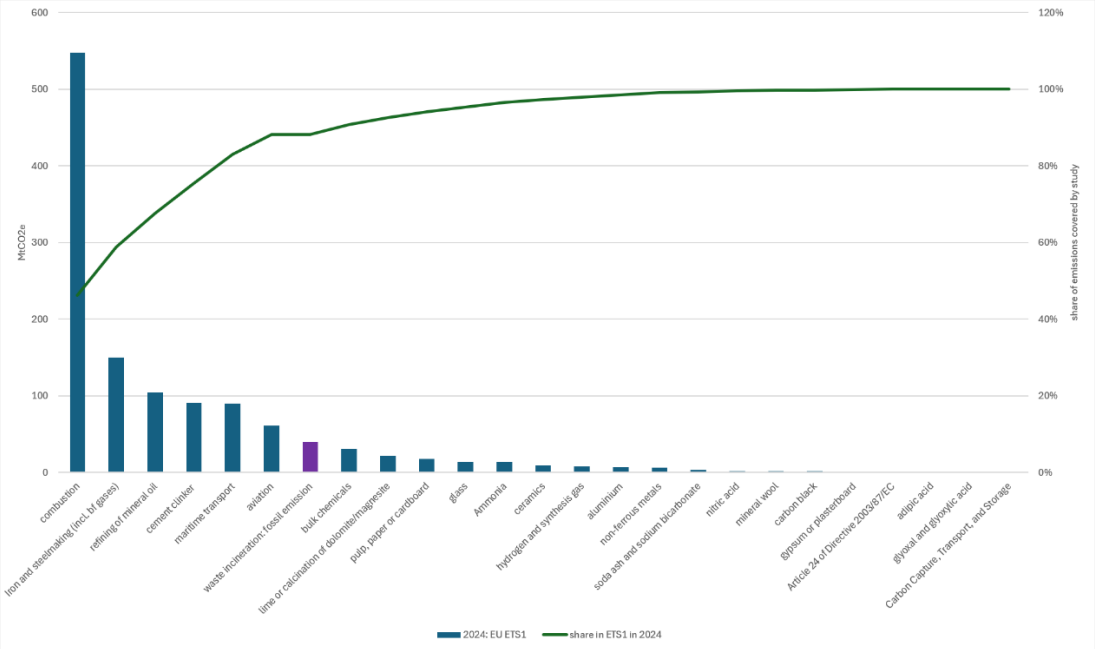
Source: Oeko-Institut

To assess the range of emissions for 2040 and 2050 we used literature findings and our own assumptions to define two scenarios: a medium-progress and a high-progress scenario. Starting point for the medium-progress scenario were scenario data from existing literature. For the high-progress scenario, we used our own assumptions or a mix of literature data to reach minimal emissions in the respective year. As the availability and range of scenarios in the literature for each sector vary, the specific approach can differ from sector to sector. For both scenarios, we assume that no carbon leakage occurs, hence production volumes in Europe are not reduced in favour of increasing import volumes of industrial goods. The following table summarises the scenario approach and major characteristics of the two scenarios.

Medium-progress scenario	**High-progress scenario**
Based on existing scenarios from literature if available and authors' own assumptions to close data gaps	Based on existing scenarios from literature complemented with additional assumptions for single parameters to reach minimal emissions in 2040 and 2050
Central items of the storyline per scenario	
✓ Increase or limited, demand-driven decrease of production volumes in many cases ✓ Medium availability of technologies, feedstocks and infrastructure connection taken from literature	✓ Reduction in product demand leading partly to lower production volumes for example due to increased use of alternative products and high product efficiency ✓ High availability of technologies, feedstocks and infrastructure connection

All emissions covered by the EU-ETS1 are included in our analysis. We use activity codes to attribute emissions to different industries and activities, and clustering to arrive at the level of sectors. For the top 14 sectors, accounting for 99% of EU-ETS1 emissions in 2024 (see Figure 1-2), we perform a detailed analysis, while we use a top-down approach for the remaining ones. Additionally, we include emissions from waste incineration in our analysis, as this sector is already subject to monitoring and reporting under EU-ETS1 and is proposed to be gradually obligated to surrender EUAs as from 2031 (EC 2026).

Figure 1-2: Emissions in the EU-ETS1 by activity and coverage within this study



Source: Oeko-Institut based on EEA (2026b)

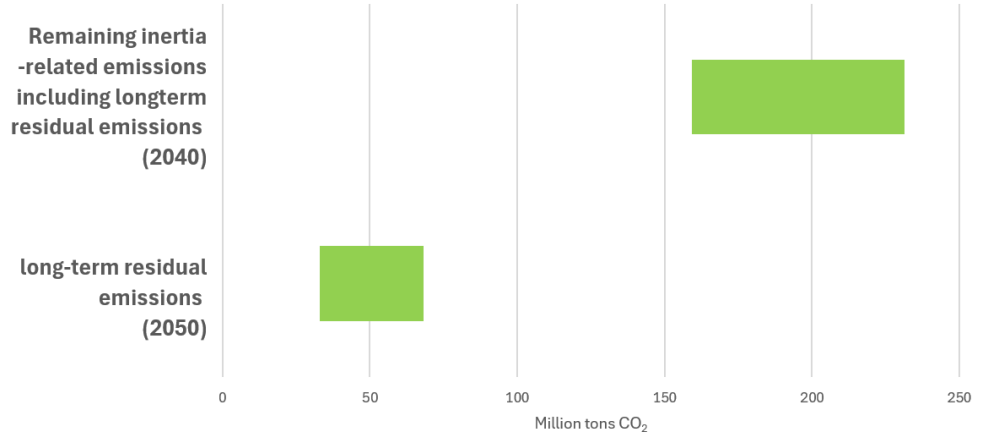
For each sector we analyse current literature on transformation scenarios and technology roadmaps and extract scenarios and assumptions that fit a medium- and a high-progress scenario. The sector-specific analysis is documented in detail in Part II of this study.

2 Quantifying residual emissions

In summary, the sector-specific results show that:

- Total of **remaining inertia-related emissions and long-term residual emissions** range between **159 and 231 million tonnes of CO_2 in 2040**.
- **Long-term residual emissions** range between **33 and 68 million tonnes of CO_2 in 2050.**

Figure 2-1: Residual emissions - overview



Source: Oeko-Institut

Detailed results showing the share of each sector are illustrated in Figure 2-2. Only a few sectors are expected to continue evidencing long-term residual emissions in the high-progress scenario in 2050. Emissions are expected from iron and steel, cement, lime, waste incineration, glass, ceramics and hydrogen and syngas industries as well as the category 'others' which includes all sectors not analysed in detail. There are **various reasons why these sectors account for long-term residual emissions**:

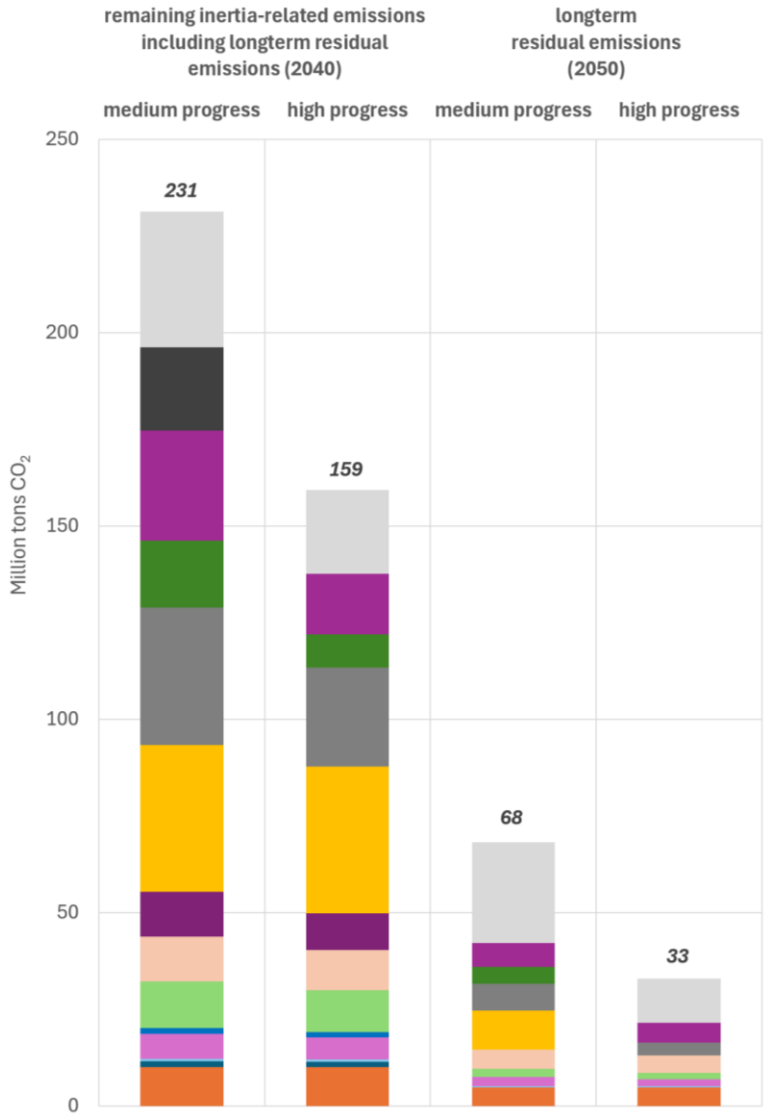
- Incomplete carbon capture of remaining process-related emissions (about 10-15% are not captured). This is relevant for the sectors waste incineration, cement, lime, glass and ceramics.
- Within the sectors with process-related emissions some installations are considered to be too small to be viable for carbon capture even in the long term. Relevant sectors are glass, non-ferrous metals, waste incineration, ceramics and some processes in the "other sectors" category.
- Emissions from the burn-off and consumption of electrodes and coal foam, especially in iron- and steelmaking, but also in non-ferrous metals production.

Compared to the long-term residual emissions in the high-progress scenario, there are a few **reasons for higher emissions in some sectors in the medium-progress scenario in 2050.** The medium-progress scenario is based on scenarios found in the literature including higher production volumes in some sectors.

- Higher production volumes in some sectors lead to higher emissions, if production is not based on fully climate-neutral routes. Emissions from incomplete carbon capture (about 10-15% remain uncaptured) that scale directly with higher production volumes are the main contributors here. This is the case for waste incineration, cement, glass, lime and ceramics.
- In the refining sector significant emission reductions are achieved through lower demand for oil products, energy-efficiency improvements, the use of low-carbon energy sources and the deployment of CCS. However, these measures do not fully abate emissions. In the medium-progress scenario, refineries continue to rely on fossil crude oil, while syncrude as an alternative feedstock is only considered in the high-progress scenario.
- In the sector aviation and maritime transport, the medium-progress scenario assumes remaining emissions of ~10MtCO_2 in 2050 even though there is no technical reason to not fully abate emissions from burning fossil fuels. This reflects the difference between remaining emissions in scenarios found in the literature compared to long-term residual emissions. The massive uptake in volumes of e-fuels and biofuels in the transport sector needed to reach climate neutrality and the assumption that this uptake could not take place in time is the major reason for remaining emissions in the medium-progress scenario in 2050.

In all sectors, emission levels for 2040 are higher than for 2050. This is due to inertia in the transition of current production practices towards carbon-neutral production routes. The ramp-up of decarbonisation technologies, including associated infrastructures, and the availability of feedstocks can be accelerated by a clear regulatory framework as well as reliable financial support and de-risking.

Figure 2-2: Residual emissions - share of each sector



Sector (activity code)				
waste incineration (-)	35.2	21.7	26.0	11.4
combustion (20)	21.5	-	-	-
iron and steel (22;23;24;25)	28.5	15.6	6.2	5.1
refining (21)	17.3	8.6	4.3	-
cement (29)	35.6	25.5	7.0	3.4
aviation and maritime transport (10;50)	38.0	38.0	10.0	-
bulk chemicals (42)	11.5	9.4	-	-
lime (30)	11.6	10.5	5.0	4.5
paper (35;36)	3.7	3.2	-	-
glass (31)	8.3	7.6	2.2	1.7
ammonia (41)	1.5	1.3	-	-
ceramics (32)	6.4	5.7	2.4	1.8
H2 and synthesis gas (43)	0.7	0.7	0.4	0.4
aluminium (26;27)	1.5	1.3	-	-
others (28;33;34;37;38;39;40;44;45;99)	10.1	10.1	4.8	4.8

Source: Oeko-Institut

3 Overall findings

3.1 Contributors to long-term residual emissions

The study shows that there are four main contributors to long-term residual emissions:

- CO_2 that is not captured by carbon capture units (we assume a capture rate of 85% for waste incineration and 90% for all other applications).
- Emissions of installations that are assumed to be too small to be equipped with a carbon capture unit or to be connected to CO_2 transport infrastructure.
- Consumption and burn-off of electrodes in steelmaking and non-ferrous metals production.
- Emissions from few processes (including the ones mentioned above) that have a small share in total emissions, where the required new technology is currently at a low TRL and might not be available in time (e.g. alternative reducing agents in some non-ferrous metals production processes).

3.2 Risks leading to high remaining inertia-related emissions

The study found that there are some major risks that lead to a slow uptake of measures to reduce emissions:

- Slow or not focussed development and commercialisation of necessary technologies. Most importantly, this relates to electricity-based high-temperature heat generation technologies, direct synthesis of methanol and processes in the chemical industry such as methanol-to-aromatics.
- Lack of transmission/transport infrastructure (electricity, hydrogen, and CO_2) including grid connection of the installations.
- Low availability or high costs of necessary energy carriers and feedstocks, especially renewable electricity and hydrogen and its derivatives.
- Lack of financial capacity for industries to make large-scale investments into transformation technologies.

3.3 Overarching enabling actions for industry sectors

For each industry we compiled the requirements to achieve the level of long-term residual emissions (in section 3 of the respective sector factsheet in Part II). Based on the findings we suggest the following overarching enabling actions for industrial decarbonisation:

- Secure financial means for transformation technologies (private capital, public funding, etc.) for both OPEX and CAPEX costs
- Secure low-cost renewable electricity hydrogen, and CO_2 transport and storage capacities (if needed) for example via long-term contracts

- Maintain high innovation efforts to reach technology leadership in zero-carbon technologies (e.g. electricity-based high-temperature heat supply)

3.4 Overarching enabling actions for policy makers

For industries to reach long-term residual emissions, there needs to be a backbone of energy carriers, feedstocks and infrastructures facilitated and incentivised by policy makers. We suggest that policy makers make sure that:

- Renewable electricity production technologies are deployed at a high level, and renewable electricity is available at low cost.
- Transport infrastructure for electricity, hydrogen and CO_2 is available (including grid connections) and the market ramp-up is actively coordinated.
- De-risking for CAPEX and OPEX for climate-neutral technologies is provided.
- Societal acceptance for infrastructures such as grids, RES-E units, new industrial plants as well as for financial support towards a just industrial transition is largely given.
- Suitable frameworks for the phase-out of fossil infrastructure are in place.

Part II: Methodological background

1 Introduction

1.1 Background and goal of study

The European Union (EU) has committed to achieving climate neutrality by 2050 and to reaching at least 85% reduction of domestic emissions by 2040[1]. Whether these targets can be met will depend not only on the scale-up of renewable energy and efficiency improvements, but crucially on the volume and distribution of remaining unabated greenhouse gas (GHG) emissions in 2040 and 2050. These emissions must ultimately be balanced by carbon dioxide removal (CDR) to achieve net-zero or net-negative emissions. EU climate law mandates the Commission to review regulation and ensure that the role of domestic permanent removals is properly reflected in the EU-ETS1 to compensate for remaining emissions[2]. The magnitude of remaining emissions therefore directly determines the scale of CDR required, with important implications for technological feasibility, costs, sustainability, and societal acceptance.

The modelling done for the 2040 target impact assessment estimates remaining emissions of about 200 to 285 Mt CO_2 in the EU-ETS1 in 2040. The lower number corresponds to an EU-wide 90% domestic emission reduction, the higher to a 85% domestic reduction. (Graichen 2026) While the 2040 EU-ETS1 proposal by the Commission sets the cap in line with these modelling results, the effect of supply beyond the cap allows much higher emissions in 2040 (WWF Deutschland 2026). Moreover, the modelling clearly lacks ambition in terms of decarbonisation efforts.

In current policy debates, the concepts of “residual emissions” and “hard-to-abate sectors” are frequently invoked to justify decarbonisation progress in certain sectors, particularly energy-intensive industries. At the same time, expectations regarding the future availability of CDR technologies (such as bioenergy with carbon capture and storage (BECCS) or direct air capture with storage (DACCS)) are often high. However, CDR options are associated with high costs, uncertain scalability, limited sustainable biomass resources, infrastructure constraints, and potentially slow deployment speeds[3]. Consequently, the higher the level of remaining emissions, the greater the reliance on possibly expensive and uncertain CDR solutions. Conversely, minimising unabated emissions reduces both the economic burden and the systemic risks associated with large-scale CDR deployment and preserves the potential for net-negative emissions beyond 2050.

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1 The amended climate law sets an emission reduction target of 90%, however international carbon credits can contribute up to 5% to the target. https://data.consilium.europa.eu/doc/document/PE-5-2026-INIT/en/pdf

2 https://data.consilium.europa.eu/doc/document/PE-5-2026-INIT/en/pdf

3 https://www.oeko.de/publikation/assumptions-on-potentials-for-carbon-dioxide-removals-in-the-eu/ | https://www.oeko.de/publikation/how-to-measure-and-quantify-biogenic-carbon-removals/ | https://www.agora-industrie.de/publikationen/carbon-capture-and-storage-ccs-in-der-energiewende-zur-klimaneutralitaet | https://www.nabu.de/imperia/md/content/nabude/240924-nabu-ccs-studie-securing-the-underground-kurz-englisch.pdf | https://www.oeko.de/en/publications/second-assessment-of-the-draft-technical-specifications-for-certification-under-the-eu-crcf-1/

Despite the centrality of residual emissions to EU climate strategy, the term itself lacks a robust and consistent definition. In many instances, "residual" is used descriptively to denote emissions that remain after assumed (economically viable) mitigation efforts, rather than normatively to reflect emissions that are truly unavoidable from a technological and systemic perspective. Moreover, available studies project a wide range of residual emissions across sectors, reflecting differing assumptions about technological progress, cost developments, effort sharing between sectors, the allocation of scarce renewable electricity, renewable hydrogen and sustainable biomass, and the distribution of CDR technologies. These variations result in markedly different estimates of how much "space to emit" individual sectors would require in 2040 and 2050.

Current policy discussions have increasingly focused creating liquidity or flexibility within the EU-ETS1 framework. Apart from the European Commission's impact assessment for the 2040 climate target and the EU-ETS1 impact assessment (both based on the PRIMES model) there are few comprehensive overviews that critically assess the minimal technically and economically achievable level of unabated emissions across sectors.

The goal of this study is to support the debate on residual GHG emissions currently covered by EU-ETS1 (plus waste incineration) based on data from existing literature. To do so, we performed individual research of residual emissions for the most relevant industry sectors for 2040 and 2050 including waste incineration and aviation and maritime transport and employed a tractable top-down approach for the remaining emissions covered by EU-ETS1.

Calculated total emissions provide a robust orientation on the order of magnitude of residual emissions from installations covered by EU-ETS1 in 2040 and 2050. The sector-specific residual emissions can act as a starting point for discussions of sectoral transformation pathways.

This study also discusses the term "residual emissions" and aims at enhancing the discussion. The term "residual emissions" is not commonly defined. We differentiate between emissions that remain during the transformation process of the economy due to slow uptake and emissions that are expected to remain in the long term due to technical reasons.

1.2 Research question

Against this background, this study aims to assess the potential volume and sectoral distribution of remaining or residual emissions in the EU-27 in 2040 and 2050. The central research question is: **What could be the scale of residual emissions consistent with technological abatement potentials and ambitious decarbonisation pathways?**

The analysis focuses on sectors covered by the EU-ETS-1, with an emphasis on industry, and evaluates the extent to which currently available and foreseeable mitigation technologies could reduce emissions by 2040 and 2050. As a precursor, we set robust guardrails to count emissions towards these minimal volumes by discussing a range of definitions of the term "residual emissions". By grounding the assessment in

technological abatement potentials rather than model-based economic equilibrium outcomes, the study seeks to provide a transparent benchmark for right-sizing residual emissions and informing policy decisions on EU-ETS1 design, effort sharing, and the strategic deployment of CDR.

The analysis covers countries participating in the European Union Emissions Trading System (EU-ETS1) and focuses on the time horizons 2040 and 2050. It primarily assesses carbon dioxide (CO_2) emissions. The sectoral scope focuses on industries accounted for in the EU-ETS1 as well as waste incineration and international transport.

1.3 Methodology and research steps

To assess the range of emissions for 2040 and 2050 we used literature findings and our own assumptions to define two scenarios: a medium-progress and a high-progress scenario. Starting point for the medium-progress scenarios were scenario data from existing literature. For the high-progress scenario, our own assumptions or a mix of literature data was used to reach minimal emissions in the respective year. As the availability and range of scenarios in the literature for each sector vary, the specific approach can differ from sector to sector. For both scenarios, we assume that no carbon leakage occurs, hence production volumes in Europe are not reduced in favour of increasing import volumes of industrial goods. The following table summarises the scenario approach and major characteristics of the two scenarios.

Medium-progress scenario	**High-progress scenario**
Based on existing scenarios from literature if available and authors' own assumptions to close data gaps	Based on existing scenarios from literature complemented with additional assumptions for single parameters to reach minimal emissions in 2040 and 2050
Central items of the story line per scenario	
✓ Increase or limited, demand-driven decrease of production volumes in many cases ✓ Medium availability of technologies, feedstocks and infrastructure connection taken from literature	✓ Reduction in product demand leading partly to lower production volumes for example due to increased use of alternative products and high product efficiency ✓ High availability of technologies, feedstocks and infrastructure connection

The research follows the steps and methodologies shown in Table 1-1.

Table 1-1: Methodology and research steps

Step	Research steps	Methodology
1	What are the relevant EU-ETS1 sectors, based on overall emissions today?	Data analysis based on verified emission data in EU-ETS1
2	How can "residual emissions" be defined to account for "minimal residual emissions"?	Literature review; development of authors' own definition based on knowledge gained from sector research (step 4)
3	Which technical abatement potentials are available per sector and which emissions cannot be abated?	Literature review of scenarios and roadmaps as well as technical reports on technologies
4	What are the minimum GHG emissions per sector based on literature?	Literature review of scenarios and roadmaps; structured data gathering in factsheets; own scenario building or parameter assumptions per sector based on expert knowledge
5	What are the overall minimal GHG emissions for the sectors in scope in 2040 as well as 2050?	Summing up sector results

Source: Oeko-Insittut

1.4 Limitations of methodology

- We did not perform our own integrated modelling under consistent scenarios. We tried to create consistency through the choice of decarbonisation scenarios and the common set of general assumptions (see Section 0, and Figure 2-1 and Figure 4-1). Also, we performed some checks on important volumes for biomass and hydrogen.
- We did not analyse the individual infrastructural, economic and site-specific situation of each installation. Neither do we consider industrial clusters or integrated production sites. We use proxies like average fleet age and emission volume thresholds to assess decarbonisation speed and the possibility for CCS connections. However, we did not assess the availability of access to electricity, carbon-neutral fuels or feedstocks.
- The analysis is based on literature, and we do not undertake our own technology research at sector level. Interviews and further discussions with other sector experts can further substantiate the findings and can also identify crucial interdependencies or restrictions.

2 Defining residual emissions

In current policy debates, the concepts of “residual emissions” and “hard-to-abate sectors” are frequently used, however there is no clear definition of the terms. This bears the risk that individual definitions do not match and debates lack a common ground. In this study we do not come up with our own definition of residual emissions, however, we assess the various definitions in the current literature and draw conclusions for this study.

2.1 Residual emissions in the literature

In the literature “residual emissions” and “hard-to-abate emissions” are two closely linked concepts. The literature suggests that residual emissions are a descriptive term, referring to the physical amount of emissions remaining once carbon neutrality is reached, hard-to-abate emissions refer to an evaluation of whether there are significant feasibility challenges for GHG emission abatement (Smith et al. 2024; Carbon Market Watch 2026; World Resources Institute 2025). Dufour-Décieux et al. (2025) put forward a techno-economical definition of hard-to-abate emissions. They define hard-to-abate emissions as *“those GHG emissions that can be reduced to zero more efficiently with direct air carbon capture and storage (DACCS) than with the best alternative abatement option.”* (Dufour-Décieux et al. 2025, pp. 1–2). This simply states that if there is no economically viable alternative that can be implemented more cost efficiently to avoid emissions than DACCS, these emissions can be considered hard-to-abate and will remain residual emissions. However, as today it is unclear what the future costs of DACCS will be, this definition can have a large impact on today’s abatement efforts: If low DACCS costs are expected more processes and emission sources will qualify as hard-to-abate emissions and therefore less emissions will be avoided.

But there are also other levels to it: Whether an abatement option is applied depends not only on its technological readiness level and its economic feasibility, but also on its societal and political acceptance. An option that is economically feasible but hardly accepted has little chances in being applied. This social and political discussion on which emissions to avoid, is a discussion on acceptability of the respective abatement options. Given that an option shows a sufficient technological readiness and is socially accepted it can be implemented. An example for an effective social solution that highly depends on acceptance is a reduction of air travel as it completely depends on individual consumption decisions and lifestyle choices (European Investment Bank 2020). In the United Kingdom the Jet Zero Strategy names demand reduction as one part of their strategy to bring down emissions of air travel (Department of Transport 2022). An abatement option that experienced substantial changes in its acceptance is the fuel switch from conventional to battery electric trucks. Their application was regarded critically in Germany in the past and experienced a marked acceptance growth, with most companies surveyed expecting it to become a dominant technology going forward (Oeko-Institut 2026).

In this study the focus lies on the term ‘residual emissions’. The literature assessment shows that the term ‘hard-to-abate’ can be defined on various levels and in the end is a result of a political and societal negotiation process.

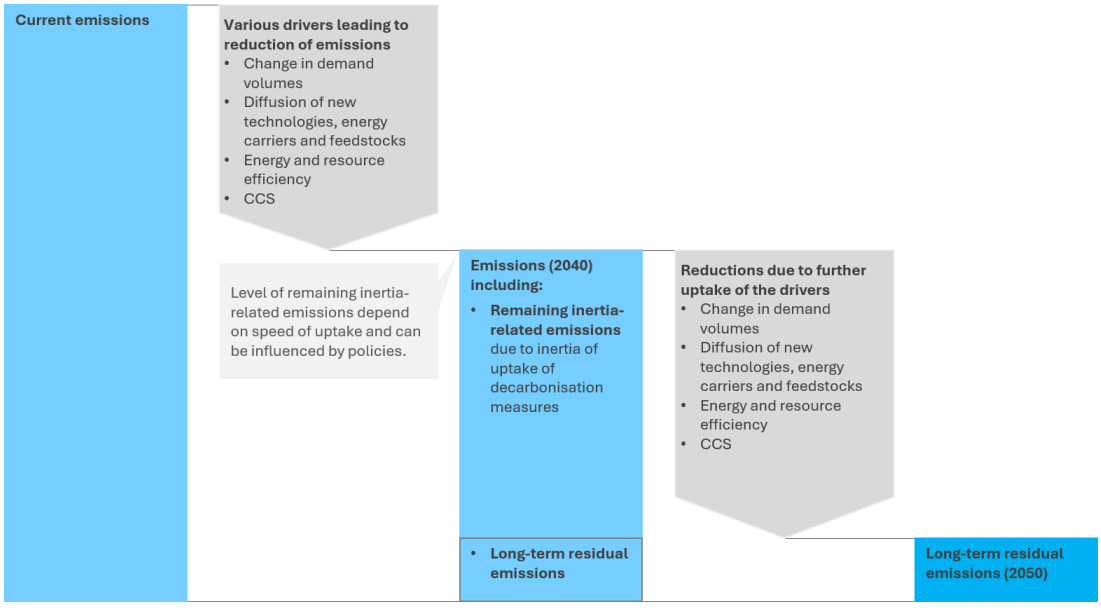
2.2 Conclusions for this study

The literature review implies that the concept of residual emissions does not have a single, widely accepted definition. In particular, the term 'residual emissions' is not defined solely on the basis of technological feasibility. Whether mitigation options are economically feasible or socially acceptable are further criteria considered. However, assumptions about which technologies or measures will be economically applicable or socially acceptable become increasingly uncertain when looking 15 to 25 years into the future and are very dependent on political and regulatory frameworks.

To differentiate between emissions that remain during different stages of the transformation process of the economy this study distinguishes between (1) remaining emissions due to slow uptake of the transformation and (2) emissions that are expected to remain in the long term due to technical reasons (Figure 2-1):

- **Remaining inertia-related emissions** are defined as emissions that could technically be further reduced but remain at a certain level and specific point in time due to a slow uptake of abatement measures. One reason could be the time required for technology uptake or connection of installations to relevant infrastructures. Therefore, the remaining inertia-based emissions reported for 2040 in this study are not considered technically unavoidable in the long term. They rather reflect the fact that there are technical, financial, infrastructural, societal and political/regulatory constraints that slow down the uptake of measures.
- **Long-term residual emissions** are defined as emissions that cannot be further reduced based on today's technology outlook. These emissions consist of remaining process-related emissions due to a lack of technology and absence of infrastructure access. We assume in this study that for most sectors, the level of long-term residual emissions can be reached by 2050.

Figure 2-1: Approach to residual emissions



Source: Oeko-Institut

The distinction between remaining inertia-related emissions and long-term residual emissions follows our methodological approach of the study. We do not optimise our own scenarios but rather use ambitious scenarios or single parameters (such as technology uptake in time) from the literature to estimate emissions. The resulting estimates per sector are therefore not a forecast of future emissions. They rather show a range of emissions that can be reached following ambitious pathways based on the current outlook for available and emerging technologies.

3 Selection of sectors

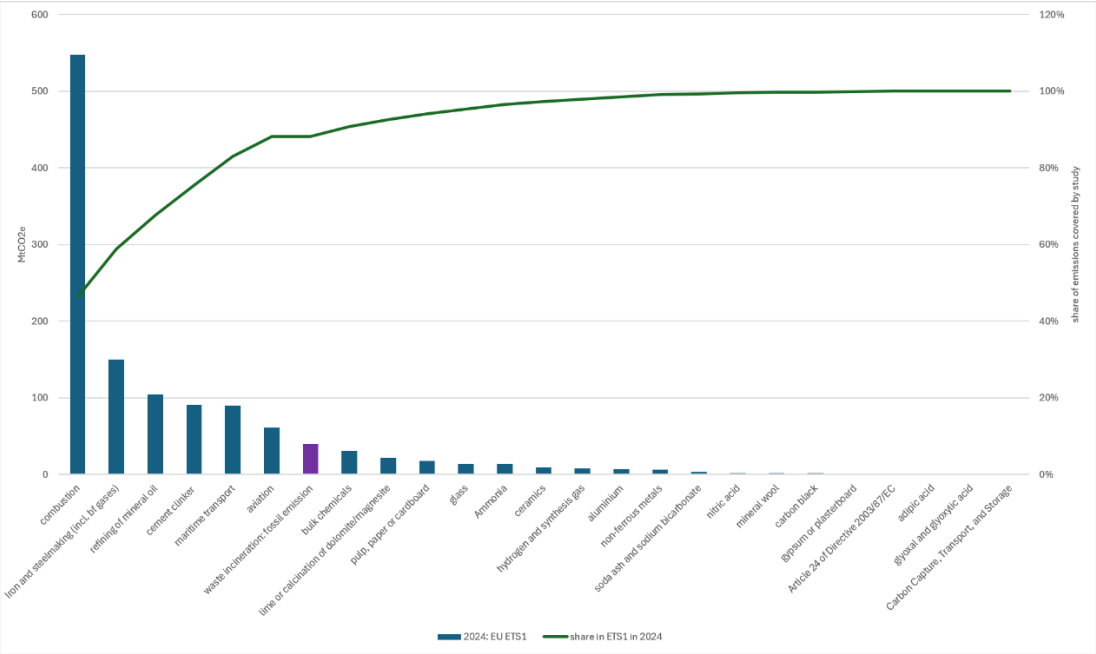
All emissions covered by the EU-ETS1 are included in our analysis, but with a differentiation in the detail of analysis. EU-ETS1 currently covers a total of 28 activities of which 26 are associated with stationary installations and two are transport activities (European Union 2024). We use activity codes to attribute emissions to different industries and activities, and clustering (e.g. for iron- and steelmaking, pulp and paper, and primary and secondary aluminium) to arrive at the level of sectors. Note that emission estimates calculated with the described approach underestimate emissions associated with some activities. E.g., coking plants, blast furnaces in the ironmaking process, but also refineries all generate substantial amounts of waste gases. The generation is directly linked to the respective production process and would not occur otherwise. These gases are typically combusted for on-site heat or power generation and reported under the combustion activity code. Likewise, the production of bulk chemicals requires substantial heat input, where some of the heat supply is reported under code 42 but some also comes for combustion installation reporting under code 20. Moreover, the attribution to an activity code is to some degree left to the individual obligated entity, again allowing to choose between combustion and the respective production as activity codes. While this might shift some of the sectors in the ranking established in Figure 3-1, it does not pose a problem to the subsequent analysis, as the analysis is based on technology-specific emission factors that fully account for direct emissions associated with the respective production route.

For the top 14 sectors[4], accounting for 99% of EU-ETS1 emissions in 2024 (see Figure 3-1), we perform a detailed analysis, while we use a top-down approach for the remaining ones.

Additionally, we include emissions from waste incineration in our analysis, as this sector is already subject to monitoring and reporting under EU-ETS1 and proposed to be gradually obligated to surrender EUAs starting in 2031 (EC 2026). A detailed sector-level analysis is also performed for this sector.

[4] We merged the aviation and maritime sectors.

Figure 3-1: Emissions in the EU-ETS1 per sector



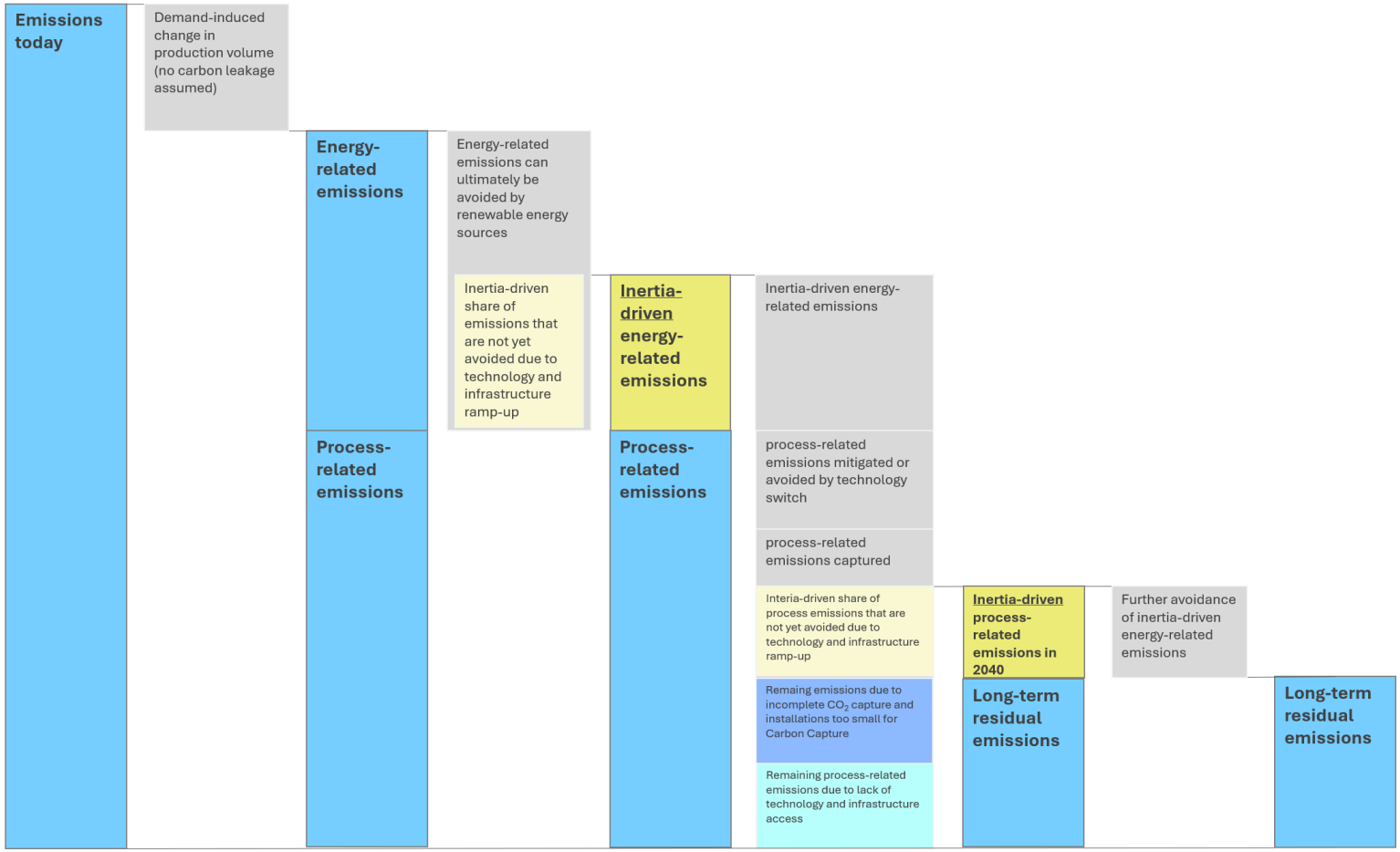
Source: Oeko-Institut based on EEA (2026a)

4 General assumptions

In this section it is described how general assumptions are defined for each sector covered. These are assumptions that are applied to all sectors when calculating remaining inertia-related emissions in 2040 or long-term residual emissions in 2050. This section also includes general assumptions on the scope of emissions considered.

Figure 4-1 shows the main assumptions and how these lead to the previously defined remaining inertia-related emissions in 2040 and long-term residual emissions in 2050. Total emissions today can be reduced by change in demand if feasible in some sectors. This does not include demand reduction at the cost of increasing import dependency. Remaining energy-related emissions are abated using renewable energy sources. Slow uptake of electricity-based technologies and infrastructures leads to an inertia-driven share of emissions that are not yet avoided. Process-related emissions can partly, and only in some sectors, be avoided by a technology switch, while most of them need to be captured and stored. However, again slow uptake might lead to remaining inertia-related emissions. In addition, some of the CO_2 will not be captured because some installations are too small for carbon capture and capturing is assumed to be incomplete. Once also remaining inertia-related process-emissions are abated by a further uptake of CCS technologies, the level of long-term residual emissions is reached.

Figure 4-1: General assumptions leading to long-term residual emissions



Source: Oeko-Institut

4.1 Scope of emissions

The scope of this report are emissions in the EU-ETS1 which covers large stationary installations as well as aviation and maritime transport. Only direct emissions from the installations (emissions at the installation's site) are relevant for the EU-ETS1 while indirect emissions (e.g. upstream methane or electricity consumption) are excluded. These emissions can nevertheless be significant and can be addressed by companies, for example through fuel switching, the procurement of renewable electricity, or other measures.

Scope 1 emissions are automatically reduced when burning fossil fuels at the installation is replaced by electricity-based technologies (electrification) as there are no direct CO_2 emissions from burning fuels at the site anymore. However, even if Scope 1 emissions at the installation fall to zero, substantial emissions may still occur if the electricity used has a high carbon intensity. This highlights the importance of ensuring sufficient renewable electricity (RES-E) supply at the system level.

In general, the EU-ETS1 covers only CO_2 emissions. As an exception, for a few activities other greenhouse gases are also included in the EU-ETS1:

- Emission of perfluorocarbons from aluminium production
- Emission of nitrous oxide from production of nitric acid, adipic acid, glyoxal and glyoxylic acid
- Emissions of methane and nitrous oxide from maritime transport

The EU-ETS1 covers the European Economic Area (EEA) which includes the 27 EU member states as well as Norway, Iceland and Liechtenstein. We define the industry part of the EU-ETS1 as all activities except combustion, aviation and maritime transport.

4.2 Production volumes

A central assumption made for this study was that imports of industrial products are not to be increased. The scenarios chosen for each sector in this study do not assume that production in Europe decreases at the cost of increased (lower-cost, higher-emission) imports from outside of Europe. Therefore, the scenarios exclude carbon leakage.

Nevertheless, production volumes can be reduced or increase due to other reasons. Reasons for increased production volumes or general activity in some industries range from robust trends (eg. transport) to active support of domestic production of certain materials because they are assumed to be relevant for the modernisation of the economy (eg. aluminium). Reasons for decreased production can range from material efficiency potentials (eg. cement) to alternative products (eg. non-synthetic fertilisers).

4.3 Circularity

Both the medium-progress as well as the high-progress scenarios include secondary production if available. The parameters chosen from literature include circularity aspects such as the availability of secondary feedstocks, available volumes and limitations due to impurities etc.

Increased shares of secondary production often result in significantly lower emissions per product and therefore are an option chosen in the scenarios. Limitations as mentioned above are taken from the literature and are considered in our scenarios.

4.4 Technology roll-out

One major lever to reduce emissions is the deployment of technologies that use renewable or low-carbon energy or feedstocks. These technologies can either replace a section of a process chain (eg. electrification of heat supply), or the whole process chain needs to be transformed (eg. methanol-to-olefins). Based on literature review and expert knowledge we assumed a technology roll-out for our scenarios based on the following parameters:

- Availability of technologies and their technological readiness in accordance with the timeline presented
- Age of current technologies to assess at which point in time reinvestments are likely
- Complexity and cost of technology transformation

We assumed an inertia of technology transformation especially where technologies are costly or existing technologies are not written off yet. On the other hand, we avoided assuming investments into new fossil-based technologies if non-fossil alternatives are available.

4.5 Carbon capture and storage

Carbon capture: The capture rate is an economic optimisation decision, where levelised costs are mostly driven by CO_2 concentration, scale of the gas stream, and availability of excess heat. A capture rate of 90% is the optimum in many cases (Biermann et al. 2018). It is also a regular project design assumption, especially for post-combustion capture projects. In real world operations, facilities like Mongstad, Boundary Dam or Petra Nova, have all proven to capture at least 90% of CO_2 from the treated gas if operated at full load (Hamborg et al. 2014; International CCS Knowledge Centre 2023; DOE 2020). The rate can be lower in installations with less constant production as ramping lowers the efficiency of the capture process. We assume that post-combustion capture is only applied in bulk chemicals production and in waste incineration. Waste incineration tends to have lower capture rates at 85% (IEAGHG 2020; Bisinella et al. 2021; Herraiz et al. 2026), which has been chosen for calculating residual emissions for the sector in this study. In other sectors, we assume that only process-related emissions are captured, and that required heat inputs are provided from electricity or climate-neutral energy carriers. This is the case in cement clinker production, lime production, manufacturing of glass and ceramics. In these industries, some of the currently planned designs foresee oxyfuel-based carbon capture (EC 2025; CI4C 2024; JRC 2025), while others rely on post-combustion capture (JRC 2025). While for the latter a 90% capture rate is a robust assumption, given plannable and steady production processes and existing experience, for oxyfuel a higher capture rate could be achievable as the flue gas stream has higher CO_2 concentrations and has less residues

(Wang and Shi 2024). For carbon capture in units other than waste incineration, we take 90% as a robust assumption.

CO_2 Infrastructure: To reflect techno-economical and CO_2 infrastructure constrictions we implement a minimum threshold for an installation to be considered for CCS. In the literature, there is no clear-cut threshold value. However, economies of scale for the capture unit are reported to be apparent only with flue gas rates beyond 10 kg/s (Danaci et al. 2021), which translates to 63-127 kt CO_2 per year for typical CO_2 concentration of 15%-30% found in the gas streams in cement clinker and lime production (Global CCS Institute 2021), assuming a 67% share of process-related emissions, and availability of 90%. We assume installations below this threshold to often face disproportionately high specific costs, limited infrastructure efficiency, and reduced scalability. Based on this, we only consider installations for CCS that report emissions of at least 100 kt per year in 2024. By focusing on larger installations, we align our analysis with projects that are more likely to benefit from economies of scale and that integrate effectively into CO_2 transport and storage networks. At the same time, plant size distributions vary significantly across sectors/activities, which affects the share of facilities that meet this threshold. The following table therefore illustrates, based on EU-ETS1 2024 data, what proportion of installations and what share of total emissions appear suitable for CCS under this criterion. For example, comparing the production of cement clinker with the production of ceramics shows that, although both are mineral products, cement clinker is primarily produced in large-scale plants, whereas ceramics are mainly produced in much smaller plants.

We did not take clustering options of installations into account. This might increase the number of viable installations being connected to CCS infrastructures. Also, we do not consider that due to technological learning economies of scale might become feasible with flow rates below 10 kg/s.

Table 4-1: Share of large plants in stationary activities

Activity	Activity code(s)	Share of emissions in installations ≥ 100 kt/a	Share of plants with emissions ≥ 100 kt/a
Combustion	20	89.1%	14.3%
Refineries	21	99.3%	77.7%
Pig iron and steel	22, 23, 24, 25	90.9%	21.4%
Aluminium	26, 27	88.6%	40.7%
Cement clinker	29	99.3%	90.6%
Lime, dolomite/magnesite	30	72.1%	36.4%
Glass	31	29.4%	10.2%
Ceramics	32	8.3%	1.0%
Paper	35, 36	34.6%	6.9%
Ammonia	41	99.8%	88.9%
Bulk chemicals	42	84.9%	17.1%
Hydrogen and synthesis gas	43	86.3%	32.3%
Other	28, 33, 34, 37, 38, 39, 40, 44, 45, 99	61-6%	9.7%

Source: Authors' own analysis, Oeko-Institut, based on EU-ETS1 2024 data

4.6 Availability of renewable electricity

Supply of renewable electricity: The amount of electricity needed for decarbonising the industry sectors is large. Scenario analyses by Fraunhofer ISI; Oeko-Institut; IREES (2026, p. 120) indicate for all industry sectors (also outside the EU-ETS1) an increase in demand from about 1,000 TWh in 2020 for EU-27 to about 1,800 TWh in 2050 (EU-Target and EU-Supreme scenarios). However, these scenarios are based on real production potentials (in terms of available space and uptake of RES-E deployment) for renewable electricity production found in EU-27. Based on this, this study assumes that the production potential and uptake of RES-E does not hinder the industry to transform its technological base and the switch to technologies using electricity instead of fossil fuels. However, this implies that the deployment of RES-E must be supported and promoted at all government levels to provide the necessary volumes of electricity for direct use but also as an input into hydrogen production in time.

Electricity grid: The electricity grid can be a bottleneck in some Member States for the uptake of RES-E in industries. On the one hand it might be a bottleneck for the transportation of electricity from RES-E-rich regions to the industrial centres. On the other hand, the (increased capacity of) grid connection of industrial plants can take up to several years. As this study focuses on 2040 and 2050, we assume that until then, suitable instruments have been deployed so that grid connection and grid bottlenecks are not a showstopper for the use of RES-E in industries.

4.7 Availability of hydrogen

Supply of hydrogen: Processes that cannot build on electrification due to specific reasons, depend on hydrogen in many cases as stated in the literature. This hydrogen can be supplied by renewable production routes like electrolysis making use of RES-E. Low-carbon hydrogen, resulting in residual emissions for example from non-captured CO_2 streams at autothermal reactors, is considered in some literature sources for reasons such as energy security, lower hydrogen costs during the uptake phase or based on remaining technologies from the uptake phase of hydrogen. We assume that renewable hydrogen is available in 2040 and 2050. Total demand adds up to 13-17 Mt in 2040 and 23-32 Mt in 2050. We have checked that the hydrogen demand assumed for the sectors in our scope is within the range of hydrogen production assumed by the EU Impact Assessment (EC 2024b).

Infrastructure for hydrogen: Transport of hydrogen will be key to supplying hydrogen to industrial sites. The uptake of this infrastructure has begun in recent years but is behind schedule (European Court of Auditors 2024). Therefore, some literature sources assume a slower uptake of decarbonisation technologies that depend on hydrogen. This results in remaining inertia-based emissions in 2040 especially in the medium-progress scenario.

4.8 Availability of biomass

Some of the industries covered in this study are expected to use biomass in various forms (gas, solid, liquid) to replace fossil energy carriers or feedstocks. In the EU-ETS-1, the CO_2 emissions from burning biomass are neglected. Therefore, the use of biomass can reduce CO_2 emissions in the EU-ETS1. However, the use of biomass can have negative impacts on the LULUCF sector: While emissions in the EU-ETS1 sector are reduced, negative emissions in the LULUCF sector are also reduced. This way the overall effect on emissions might be less than what is reported in the EU-ETS1 sector. Based on this effect, the use of biomass in industry sectors should be reduced to processes where other alternatives are not available, and residual biomass should be used if available. (UBA 2024, p. 22; Thünen-Institut 2023)

Sustainable biomass sources are limited (European Commission 2023). Therefore, there is a risk that if many industries build on biomass as their major pathway to reducing emissions, biomass demand will exceed the available potential. Building industrial decarbonisation strategies on solid biomass is hardly feasible as it faces constraints regarding regional distribution and an unclear development of future supply. Biomethane can be used to overcome the issue of transportation limitations, as it can be transported through the natural gas grid. Still, the development of prices for biomass or biomethane is unclear.

As a general approach, we kept the share of biomass in total energy input constant[5]. Therefore, required biomass volumes only increase in proportion to production

[5] Some industries, e.g. cement clinker production, use waste as an energy input. While both fossil-based and bio-based waste are used, they are typically of different origins and not mixed as in municipal waste. We assume that the specific input of bio-waste stays constant, while fossil-based waste is substituted with climate-neutral energy sources.

volumes. This leads to a total increase of below 50 TWh in biomass demand for all industry sectors[6] in 2040 and 2050, excluding waste incineration, bulk chemicals, aviation and maritime transport, and combustion. We deviate from the approach described above for the bulk chemicals and the transport sector. For the transport sector we base calculations on the LIFE scenario of the EC 2040 IA for the medium-progress scenario for 2040 and 2050, and for the high-progress scenario for 2040. It assumes 23% of bio-based fuel for 2040, increasing to 31% in 2050. For 2050 in the high-progress scenario, we assume moreover that remaining fossil fuels in the LIFE scenario are substituted with non-fossil fuels using the same split between fuels. This gives a final share for bio-based fuel of 39% for 2050. Similarly, we follow the maximum scenario (DECHEMA 2017) for bulk chemicals, which assumes that the share of bio-based olefins is 10% in 2040 and 15% in 2050. Total dry biomass demand for these two sectors is about 800 TWh in 2040 and 1050 TWh in 2050. To put the demand for biomass-based energy carriers in perspective: The theoretical potential of biomethane (as a fraction of overall biomass potential) in EU-27 is expected to amount to between 299 and 678 TWh. The technologically exploitable potential and economically exploitable potential are expected to be far lower (280 TWh to 170 TWh) (Vogel et al. 2026). However, substantial shares of this total demand for biomass could also be supplied from imports, as it is assumed for example in the EU-wide decarbonisation scenarios in the PATHWAYS project (Fraunhofer ISI; Oeko-Institut; IREES 2026), where bio-based energy carriers and fuels worth 1600-1700 TWh primary energy are imported to the EU in 2050.

[6] We did not examine the biomass demand in the sectors where we took a generalised approach. However, as most emissions come from non-ferrous metals production we assume a similar structure as in aluminium production, where no additional biomass is required.

5 Sector factsheets

The following section contains sector factsheets for each sector. Each factsheet includes a detailed description of the sector, the main sources of emissions, central abatement options and a description of how the high- and medium-progress scenario is implemented in the respective sector. The level of detail of the scenario descriptions depends on the availability of data from the literature.

The data shown in the sector overview is based on data extracted from the European Union Transaction Log (EUTL) for the reporting year 2024. Emissions are disaggregated by activity code to provide a detailed and consistent sectoral assessment. In the following, we define the number of active plants as installations reporting emissions greater than zero during the year 2024. For each activity code, we extracted and calculated total emissions, number of active plants as well as average and range of emissions of active plants. If not stated otherwise, process emission data for cement, lime, glass, ceramics, ammonia, nitric acid, adipic acid, iron and steel, ferroalloys, and aluminium were compiled from the Common Reporting Tables (CRT) of the 2026 National Inventory Reports (NIRs) for EU27, Norway, Iceland and Liechtenstein.[7] If not stated otherwise, 2024 production levels were also taken from the NIRs.

5.1 Combustion

Sector overview

589Mt CO_2 emissions in 2024	Share of sector emissions in Industry 2024 not available as not part of industry	**4,893** installations in EU-ETS1	Average emissions per installation: **0.1 Mt CO_2/a** range: **0.0 – 27.2 Mt CO_2/a**	**0%** process-related emissions today

Source: 2024 data from EEA (2026a)

Combustion processes include a wide range of emission sources: "boilers, burners, turbines, heaters, furnaces, incinerators, calciners, kilns, ovens, dryers, engines, fuel cells, chemical looping combustion units, flares, thermal or catalytic post-combustion units, and scrubbers (process emissions) and any other equipment or machinery that uses fuel, excluding equipment or machinery with combustion engines that are used for transportation purposes" (EC 2024a). Despite this definition the list of installations shows that almost all installations in this activity code produce heat or electricity by combustion of fossil fuels. EU-ETS1-relevant emissions stem from burning fossil fuels.

Abatement options

Abatement options mainly focus on the use of renewable energy sources to produce electricity and heat. Especially fluctuating RES-E plants need to be combined with flexibility and storage options to provide electricity when it is needed. Renewable electricity production can be based on for example wind, solar, biomass or hydropower.

[7] The geographic scope of the EU-ETS is the European Economic Area. In addition to the EU27 this also includes Norway, Iceland and Liechtenstein.
National Inventory Submissions 2026 to UNFCCC available at: https://unfccc.int/ghg-inventories-annex-i-parties/2026

Renewable heat production can be based on for example heat pumps or resistance heaters using renewable electricity, biomass or renewable gases.

Other options include the use of CCS in for example fossil natural gas-based power plants. However, this option results in remaining CO_2-emissions as not 100% of the CO_2 is being captured. In a minimal emission scenario necessary peak power plants and combined heat and power plants could run on renewable hydrogen or alternative renewable fuels, also batteries and demand side management can be used to some extent to provide flexibility (Kittel et al. 2026). However, the EU Impact Assessment assumes remaining fossil natural-gas fired heat and power plants in their scenarios in 2050 for which the "majority" is equipped with carbon capture (EC 2024b p. 32).

Requirements to reach minimal residual emissions

The top requirements to reach the level of minimal residual emissions are and uptake of RES-E in combination with:

- Improved efficiency of electricity use in all sectors (which lowers the overall need for RES-E deployment)
- Electricity grid expansion to integrate RES-E
- Sufficient short-term (eg. batteries) and long-term (eg. electrolysers and hydrogen power plants) storage options for electricity

Scenario definition

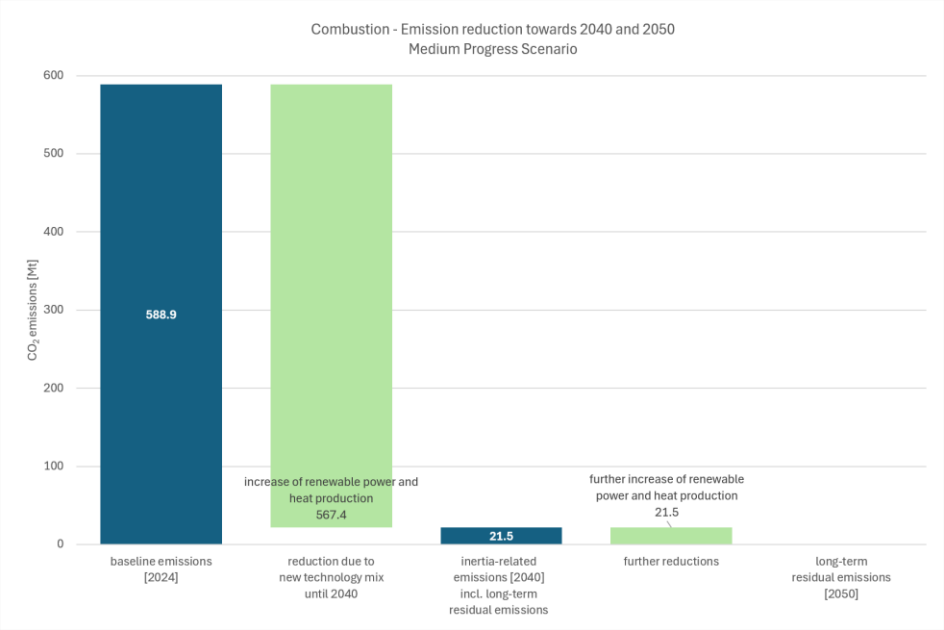
For the high- and medium-progress scenarios we used different existing scenarios. The high-progress scenario is based on CAN Europe (2024) “Paris Compatible Scenario (PAC)”. It assumes a rapid deployment of renewable power plants and reduces fossil-based power and heat production to zero as early as 2040. The medium-progress scenario is based on the EU-Target and EU-Supreme scenarios developed in the study “Pathways to an EU in 2050 with net-zero GHG-emissions” funded by the German Environment Agency (Fraunhofer ISI; Oeko-Institut; IREES 2026). Both scenarios assume a final production of 43 TWh electricity from natural gas power plants (without CCS) in 2040 and zero production in 2050. Assuming a half-and-half mix of open cycle gas turbines and combined cycle turbines the production of 43 TWh electricity results in 22Mt of CO_2 per year in 2040.

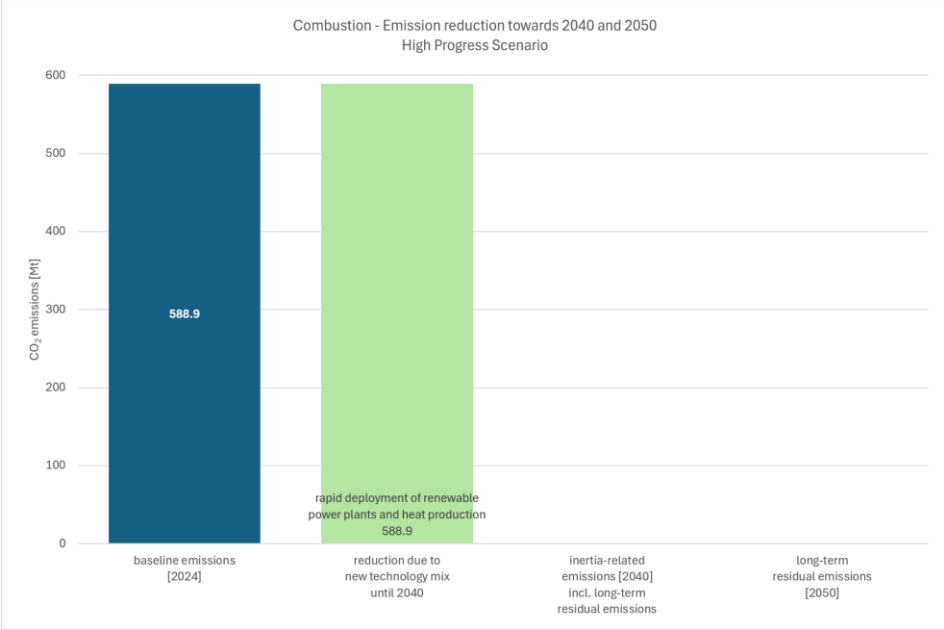
Table 5-1: Combustion – Scenarios

	Year	Medium-progress scenario	High-progress scenario
Production of fossil-based power [TWh]	2024	810	810
	2040	43	0
	2050	0	0
CO_2 emissions absolute [Mt]	2024	589	589
	2040	22	0
	2050	0	0

Source: Oeko-Institut

Quantitative results





Emissions due to burning of fossil fuels to generate power and heat can be reduced to zero when renewable energy sources are used. This is shown in the high-progress scenario. The medium-progress scenario shows that remaining production of heat and power from fossil fuels in 2040 results in substantial emissions of ~22Mt CO_2 in 2040.

5.2 Iron and Steelmaking

Sector overview







109Mt CO_2 emissions in 2024	**24.4%** share of sector emissions in total EU-ETS1 Industry 2024	**397** installations in EU-ETS1	Average emissions per installation: **0.27 Mt CO_2/a** range: **0.0 – 8.59 Mt CO_2/a**	**n/a** process-related emissions today

On the BF-BOF-route energy and process-related emissions cannot be clearly distinguished because coking coal serves as both energy source and reducing agent. However, to assess the future development this separation is not important.
Source: 2024 data from EEA (2026a)

Iron and steel are made either on the primary route or the secondary route. The primary process mainly relies on coking coal to reduce iron-ore and produce hot metal in a blast furnace. To convert hot metal into crude steel, the carbon content of the hot metal is reduced through oxidisation in a blast oxygen furnace. The liquid molten steel from the blast oxygen furnace is then cast into crude steel forms (e.g. slabs, blooms, billets) for further processing into finished steel products (EUROFER 2026[8]). About 25% of the feedstock into the basic oxygen furnace is scrap steel (BIR 2025, 10;13), which reduces the energy and carbon footprint of crude steel relative to hot metal.

On the secondary route, steel scrap is fed into an electric arc furnace (EAF). The electric arc furnace uses heat generated from electricity to melt scrap, Direct Reduced Iron (DRI) or Hot Briquetted Iron (HBI) and produces liquid steel. The electric arc is ignited using graphite electrodes which burn off during the process and need to be replaced periodically (IEA 2020). Scrap pre-heating can reduce electricity demand. Total crude steel production in 2024 was 132.2 Mt, with an EAF share of 43% (worldsteel 2026).

On the primary route, emissions stem from coking coal used as a reduction agent and for heat generation, as well as heat generated from steam coal and small amounts of natural gas. Most emissions stem from the processes in the blast furnace, smaller shares arise from fuel combustion in coking and sintering processes. Additionally, there are CO_2 emissions from the calcination of limestone, which is used to clean the flue gases, avoid impurities and increase sinter efficiency (IEA 2020). In the coke oven, the blast furnace and the blast oxygen furnace, high-energy waste gases are produced as by-products, which contain substantial shares of the carbon as CO and CO_2 originating from the fossil inputs. These gases are combusted to generate heat for internal processes but significant amounts are also exported to power plants to generate electricity for internal processes and for sales to the grid. Emissions from these power plants are reported as combustion emissions under code 20 but are directly linked to crude steel production. On the secondary route, most CO_2 emissions stem from combustion of coal and natural gas for pre-heating the scrap (currently about two-thirds) while one third originates from the burn-off of the graphite electrodes, and consumption of foam coal which is used to avoid impurities and increase electric efficiency (IEA 2020). The latter ones remain even if climate-neutral energy sources are used for pre-heating. According to Medeiros et al. (2026) typical scrap-based EAF crude

8 https://www.eurofer.eu/about-steel/learn-about-steel/what-is-steel-and-how-is-steel-made

steel requires 5-15 kg of foam coal and 1-3 kg of electrodes per tonne of crude steel which translates to 25-70 kg CO_2 per tonne of crude steel.

In terms of indirect emissions, the two routes perform very differently. On the primary route waste gases are typically used to produce electricity and heat, and integrated sites are either auto-producers or even exporters of electricity. With about 0.6 MWhel/t crude steel, electricity is the major input on the secondary route (Graichen et al. 2025). Therefore, the specific CO_2 emissions footprint of EAF-based crude steel highly depends on a decarbonised electricity input.

Abatement options

Options to achieve minimal emissions are the following, based on IEA (2020):

- Increase of EAF share
- Emission-free alternatives for pre-heating on the EAF route, these would be preferably bio-energy carriers, as they would also supply the carbon input needed to ensure the required characteristics of the steel
- Switch to H2-based DRI-EAF-route
- Switch to climate-neutral alternatives to foam coal to further reduce the carbon footprint of the EAF

Other options mentioned are a switch to an natural gas (NG)-based DRI-EAF-route with CCS, or using CCS for the BF-BOF-route: theoretically CO_2 could be captured from the syngas, where it is present in a concentrated stream, however the other three technology options are compatible with climate neutrality, while this one is not.

Requirements to reach minimal residual emissions

The top three requirements to reach the level of minimal residual emissions are:

- Large-scale availability of low-cost renewable hydrogen
  - Renewable energy uptake for renewable hydrogen production
  - Investment in large-scale electrolysis capacities
  - Investment in large-scale hydrogen transport infrastructure if relocation of current site shall be avoided
- Sustainable biomass as a carbon source
- Large amounts of renewable electricity for the electric arc furnaces

Scenario definition

For the medium-progress scenario, we assumed that the production of crude steel follows the relative changes in the STD scenario of the EC 2040 Impact Assessment (EC 2024b), with a 4% reduction of production by 2040, and 6% by 2050. For the high-progress scenario, we assume that the production of crude steel follows the relative changes in the CIRC scenario of the EC 2040 Impact Assessment (EC 2024b), with a 13% reduction (2040), and 23% (2050) respectively.

CO_2 intensities on the BF-BOF-route (1.85 tCO_2/t crude steel), the current EAF route (0.15 tCO_2/t crude steel), and the natural gas-based DRI-EAF route (0.59 tCO_2/t crude steel) are taken from Oeko-Institut (2024) and Graichen et al. (2025). For the future EAF and H_2-based DRI-EAF routes we assume 0.05 tCO_2/t crude steel, the average of the values above.

For both scenarios we assume that by 2040, all scrap that is currently used on the BF-BOF-route is shifted to the EAF route, increasing EAF-based production to 76.6 Mt. For the primary route, we assume that some sites take an intermediate step to H_2-based DRI via natural gas-based DRI, to account for the fact that H_2 will only gradually become available and to allow for a transition phase. The share of natural gas-based DRI is taken from the high hydrogen availability scenario of the Green Steel for Europe Project (Green Steel for Europe 2021) and interpolated to arrive at 2040 figures.

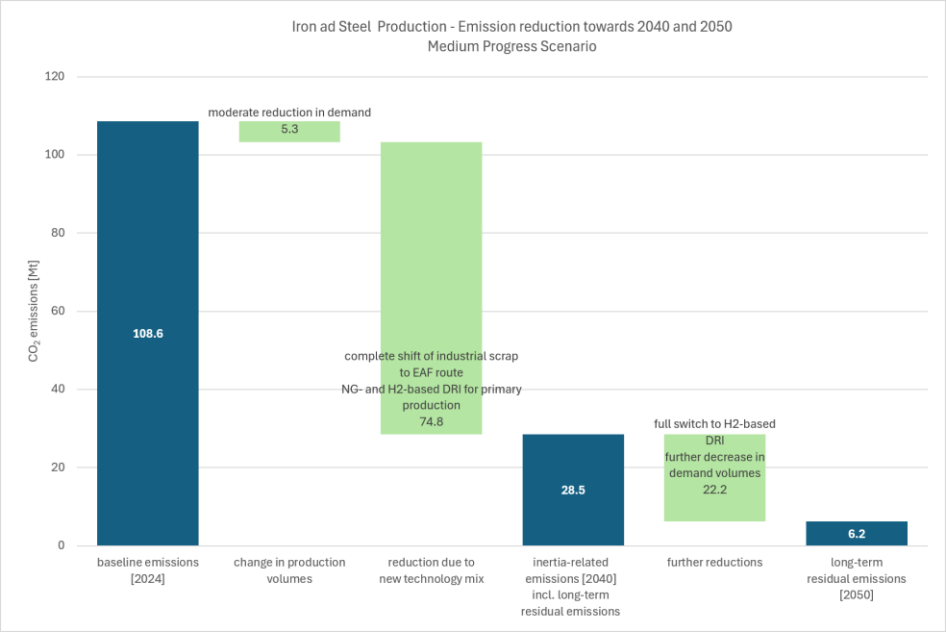
Table 5-2: Iron and Steelmaking - Scenarios

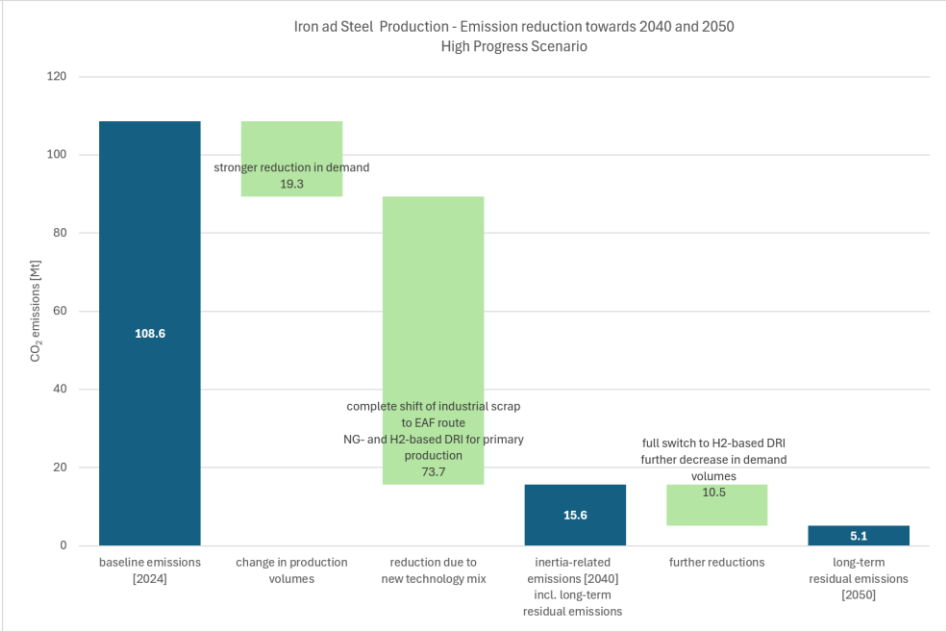
	Year	Technology	Medium-progress scenario	High-progress scenario	Source
Technology-mix	2024	BF-BOF route	57%	57%	For both scenarios we assume that by 2040, all scrap that is currently used on the BF-BOF-route is shifted to the EAF route, increasing EAF-based production to 76.6 Mt. The share of natural gas-based DRI compared to H2-based DRI is taken from the high hydrogen availability scenario of Green Steel for Europe (2021) and interpolated to arrive at 2040 figures.
		EAF route	43%	43%	
	2040	BF-BOF route	4%	0%	
		EAF route	60%	66%	
		NG-DRI-EAF route	18%	17%	
		H2-DRI-EAF route	18%	17%	
	2050	BF-BOF route	0%	0%	
		EAF route	62%	75%	
		NG-DRI-EAF route	0%	0%	
		H2-DRI-EAF route	38%	25%	

	Year	Medium-progress scenario	High-progress scenario	Source
Production [million tonnes]	2024	132.8	132.8	Data for year 2024 worldsteel
	2040	128.0	115.4	Relative changes in the STD scenario of the EC 2040 Impact Assessment (EC 2024b) for medium-progress scenario and CIRC for high-progress scenario, for 2040 and 2050.
	2050	124.4	102.4	
CO_2 emissions absolute [Mt CO_2]	2024	108.6	108.6	EEA (2026a)
	2040	29.0	16.1	Calculated with technology mix and emission intensity
	2050	6.8	5.6	
Specific CO_2 emissions [tCO_2/t $_{crude\ steel}$]	2024	1.1		
	2040	0.2		
	2050	0.05		

Source: Oeko-Institut

Quantitative results





The transition to DRI-based ironmaking is the central technological shift in both scenarios. It comes with a threefold effect. First, transitioning from the BF-BOF route even to natural gas-based DRI with EAF reduces direct emissions by about two thirds, but increases the electricity demand by 0.5-0.7 MWh/t crude steel. Second, technology choices allow for a later drop in of increasing shares of hydrogen rising to 100% without major new investment requirements. Third, scrap that is currently fed into the BOF becomes available and increases output on the EAF route[9]. A moderate reduction of crude steel production volumes further reduces residual emissions, as early as 2040.

9 To further increase the EAF share beyond the existing, the availability and quality of scrap are a crucial factor: Contamination (e.g., from copper) currently often prevents EAF-based steel from substituting high-quality flat products required for car manufacturing.

5.3 Mineral oil refineries

Sector overview

104 Mt CO_2 emissions in 2024	**23.5%** share of sector emissions in total EU-ETS1 Industry 2024	**103** installations in EU-ETS1	Average emissions per installation: **1.01 Mt CO_2/a** range: **0.00-6.98 Mt CO_2/a**	**0%** process-related emissions today

Source: 2024 data from EEA (2026a)

Mineral oil refineries convert crude oil into fuels, lubricants, and chemical feedstocks. The refining process consists of multiple process steps, these include the distillation of crude oil into various fractions, cracking of long-chained hydrocarbons and on-site hydrogen production. The process requires significant amounts of thermal energy which is provided from furnaces, boilers and CHP plants. Large parts of the energy required is covered by burning by-products (e.g. refinery gas) of the refining process. CO_2 emissions occur in many subprocesses of the refineries. Therefore, options to minimise emissions also come into play at different points in the process chain.

Relevant upstream emissions (which are not included in the EU-ETS1 scope of the mineral oil refineries sector) are emissions caused from crude oil exploration and extraction, from crude oil transport (mainly via tank ships and pipelines) and from externally sourced electricity and heat. Process emissions do not occur in mineral oil refining.

Abatement options

A strong reduction of liquid fossil fuel demand will substantially reduce the number of refineries required. In both scenarios, a reduction in production of 70% by 2040 and 90% by 2050 is assumed compared to 2024 levels. We take these production levels from SPGCI (2025).[10] To verify plausibility, we used data from the S3 and LIFE scenarios from the European Commission's 2040 Impact Assessment, adjusted them in line with our other assumptions (particularly regarding bulk chemical production), and arrived at very similar production figures for 2040 and 2050.[11]

Options for achieving minimal emissions at the refineries themselves are the following, based on Concawe (2019) and Kolmeijer et al. (2026)

- Reducing refinery gas production by advances in process and catalyst technology. Refinery gas is a methane-rich by-product of the refining process and must be used (combusted) as venting would have a much worse climate impact.
- Replacing fossil hydrogen with electrolytic hydrogen and replacing on-site fossil-based co-generation of electricity and heat with electric heaters, powered by externally sourced electricity.

[10] We adjusted the data, as the scope of the Concawe study is not only EU-27 plus Norway, but also includes the United Kingdom and Switzerland.

[11] Adjusted production level for S3 would be 4 % higher and for LIFE 8 % lower.

- Limited CCS potential due to transformation to non-fossil fuel production and various exhaust streams.
- Switch to synthetic crude oil (syncrude), a hydrocarbon mixture of renewable origin that replaces fossil crude oil as refinery feedstock. [12]

Requirements to reach minimal residual emissions

The top three requirements to reach the level of minimal residual emissions are:

- Strong reduction in demand for liquid fossil fuels across all sectors.
- Availability of sustainable hydrogen.
- Availability of syncrude.

Scenario definition

Both the medium-progress and the high-progress scenarios include a strong reduction in the consumption of oil products. This is the main driver for emission reduction as less refineries are needed when less oil products are consumed.

In both scenarios we assume that technical options at the refineries themselves are applied to increase energy efficiency and use low-carbon energy sources which lead to reduced CO_2 emissions. CCS is used as well to abate CO_2 emissions further.

In the high-progress scenario we combine the options described before with uptake of syncrude as crude oil replacement for refineries input.

Table 5-3: Mineral oil refineries - Scenarios

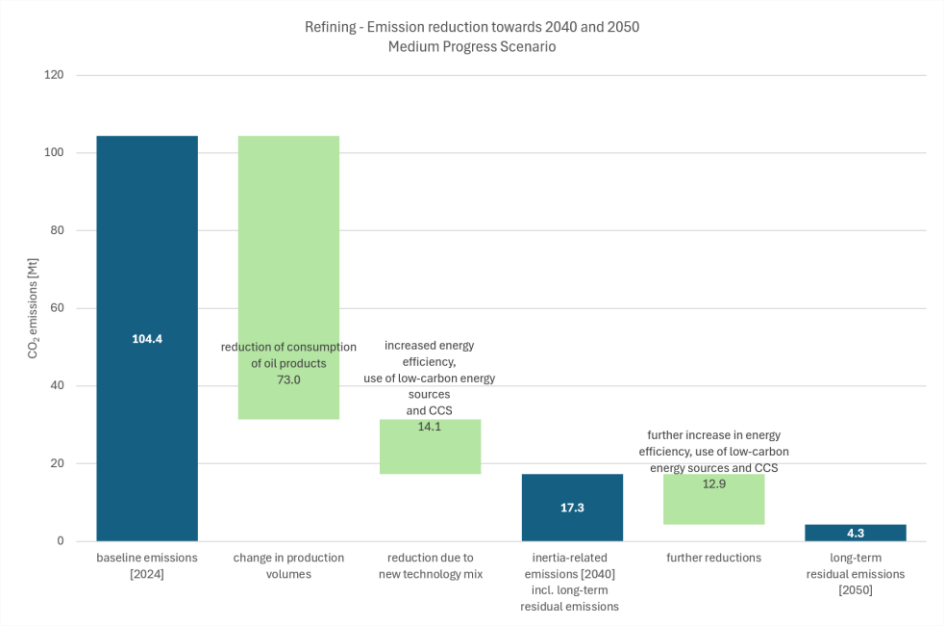
	Year	Medium-progress scenario	High-progress scenario	Source
CO_2 savings from energy efficiency	2024	0%	0%	
	2040	15%	15%	Concawe (2019)
	2050	20%	20%	Concawe (2019)
CO_2 savings from low-carbon energy sources	2024	0%	0%	
	2040	15%	15%	Concawe (2019)
	2050	20%	20%	Concawe (2019)
CO_2 savings from use of CCS	2024	0%	0%	
	2040	15%	15%	Concawe (2019)
	2050	20%	20%	Concawe (2019)
Syncrude share	2024	0%	0%	
	2040	0%	50%	
	2050	0%	100%	
Production [Mtoe]	2024	554,1	554,1	Eurostat nrg_bal_c for EU27 + NO
	2040	166,7	166,7	SPGCI (2025), scope adjusted
	2050	57,4	57,4	SPGCI (2025), scope adjusted
CO_2 emissions	2024	104,4	104,4	EEA (2026a)

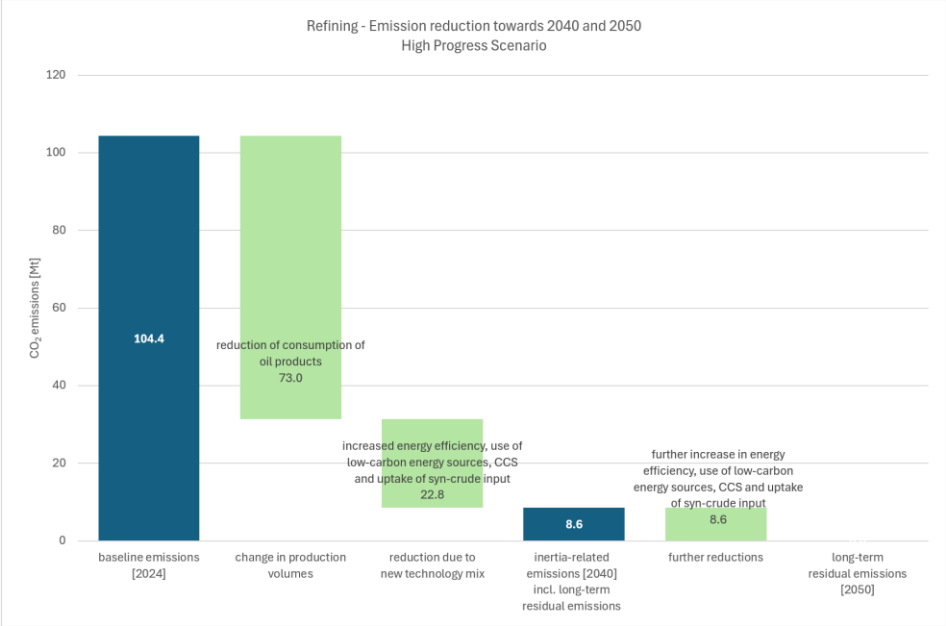
[12] To our knowledge it is not completely clear whether refining of syncrude would still be an activity covered by the EU-ETS1. While Annex I of the current EU-ETS1 directive 2003/87/EC lists “refining of oil” as an activity, the associated Monitoring and Reporting Regulation specifies monitoring rules for “monitoring of mineral oil refining activities”.

absolute [Mt]	2040	17,3	8,6	Calculated from production and technology shares
	2050	4,3	0,0	Calculated from production and technology shares
CO_2 intensity [t/t]	2024	0.19	0.19	
	2040	0.10	0.05	45% reduction in medium-progress scenario, further reduction through use of syncrude in high-progress scenario
	2050	0.08	0.00	60% reduction in medium-progress scenario, further reduction through use of syncrude in high-progress scenario

Source: Oeko-Institut

Quantitative results





In an ambitious climate protection scenario, the decisive driver of CO_2 emissions of mineral oil refineries are not changes in the refineries themselves but the overall reduction of demand for mineral oil products like transport fuels (notably gasoline, diesel and kerosene), heating oil and feedstock for the chemical industry. The demand reduction combined with the options at the refineries themselves described above lead to a decrease of emission intensity by 45% by 2040 and 60% by 2050 in the medium-progress scenario and by 73% by 2040 and 100% in the high-progress scenario. These reductions of energy intensity are achieved in the medium-progress scenario by an increase in energy efficiency, use of low-carbon energy sources and use of CCS. In the high-progress scenario, these measures are combined with an uptake of syncrude which replaces 50% of the remaining crude oil demand by 2040 and 100% by 2050. Combining these factors, CO_2 emissions of refineries can be reduced by 83% by 2040 and 96% by 2050 in the medium-progress scenario and by 92% by 2040 and 100% by 2050 in the high-progress scenario.

5.4 Cement

Sector overview

91 Mt CO_2 emissions in 2024	**20.5%** share of sector emissions in total EU-ETS1 Industry 2024	**200** installations in EU-ETS1	Average emissions per installation: **0.45 Mt CO_2/a** range: **0.0 – 2.51 Mt CO_2/a**	**67%** process-related emissions today

Source2024 data from EEA (2026a)

Cement industry emissions result from the production of clinker and comprise one third of energy-related emissions and two thirds of process-related emissions. Energy-related emissions stem from fossil fuel-fired kilns for clinker burning, and two thirds of process-related emissions result from the calcination process, where carbon and oxygen is removed from limestone (CaO_3), that mainly takes place in the precalciner. Burned clinker is the key component of cement that provides the cementitious properties (pozzolan) (Heidelberg Materials 2026).
Due to the typical size of the installations and the high emission intensity of clinker production, emissions go beyond all thresholds / de minimis regulations for production plants of EU-ETS1 coverage, thus both energy- and process-related emissions of the cement sector are covered by the EU-ETS1.

Other emissions exist which are not directly connected to the production process of cement, but rather the transportation of raw materials and the final product. Also production sites consume electricity from the grid, which is yet not carbon neutral. However, all of these emissions are not direct emissions of the cement production processes and are addressed in power generation transformation.

Abatement options

Different technologies can be applied to reduce emissions of the cement production process. Energy-related emissions can be minimised through the application of non-fossil fuels or renewable electricity. Direct process emissions need to be addressed through CCS. However, before the application of CCS, low-carbon cements with an increasing share of supplementary cementitious materials (SCMs), can reduce the clinker-to-cement-ratio and cement substitution by alternative binders can reduce the demand for clinker and thereby the absolute amount of process-related emissions (New Climate Institute 2020; Joint Research Center 2023). Finally, an overall demand reduction could further reduce absolute emissions. This, however, strongly depends on the way buildings are planned and constructed, and existing and unused buildings are used for e.g. housing instead of building new ones. As this depends on many different factors this mitigation path is not plannable (Bellona 2025). A non-exclusive list of measures that reduce emissions is the following:

- Reducing the demand for clinker by
  - Efficient use of existing buildings
    - Raw material input-sensitive construction design

- Use of alternative binder that replaces cement
- Use of supplementary cementitious materials (SCMs) that replace clinker and thereby reduce the clinker-to-cement-ratio

- Reducing energy-related emissions by
  - Increasing thermal efficiency
  - Using renewable electricity-based heat pumps
  - Using carbon-neutral fuel like hydrogen or biomass for high-temperature heat supply
- Reducing process-related emissions
  - Carbon capture, transport and storage

Due to the high share of process-related emissions that can only be reduced through alternative raw materials and changes in the concrete mix, but never be mitigated completely, the use of CCS is inevitable (Bellona 2025; New Climate Institute 2020). We assume that a maximum of 90% emissions can be captured through CCS (also see section 4.5).

Requirements to reach minimal residual emissions

The top three requirements to reach the level of minimal residual emissions are:

- CO_2 transport and storage infrastructure needs to be in place to accommodate captured process emissions.
- Renewable expansion and non-fossil fuels supply need to be secured to mitigate energy-related emissions.
- Existing potentials to reduce the demand for cement need to be exploited.

Scenario definition

For this sector two scenarios are defined: On the one hand, a scenario with a moderate increase in cement production of 20%, following the STD scenario of the EC 2040 Impact Assessment (EC 2024b) that constitutes the medium-progress scenario. On the other hand, a high-progress scenario with a decrease of production amounting to 30% by 2050, moderately exceeding the 25% reduction of the CIRC scenario of the EC 2040 IA (EC 2024b) but refraining from assuming the full use of alternative materials and resource efficiency that could sum up to 40%-75% in demand reduction (New Climate Institute 2020). The high-progress scenario is additionally characterised by cement substitution via alternative binders of 5% in 2040 and 10% in 2050 similar to assumptions used in the CIRC scenario of the EC 2040 IA (EC 2024b). The clinker-to-cement ratio is reduced for both scenarios from 77% in 2024 to 69% in 2040 and ultimately to 60% in 2050 (c.f. New Climate Institute 2020). Thereby, we assume a limited use of alternative SCMs, where a more intensive use could further reduce the

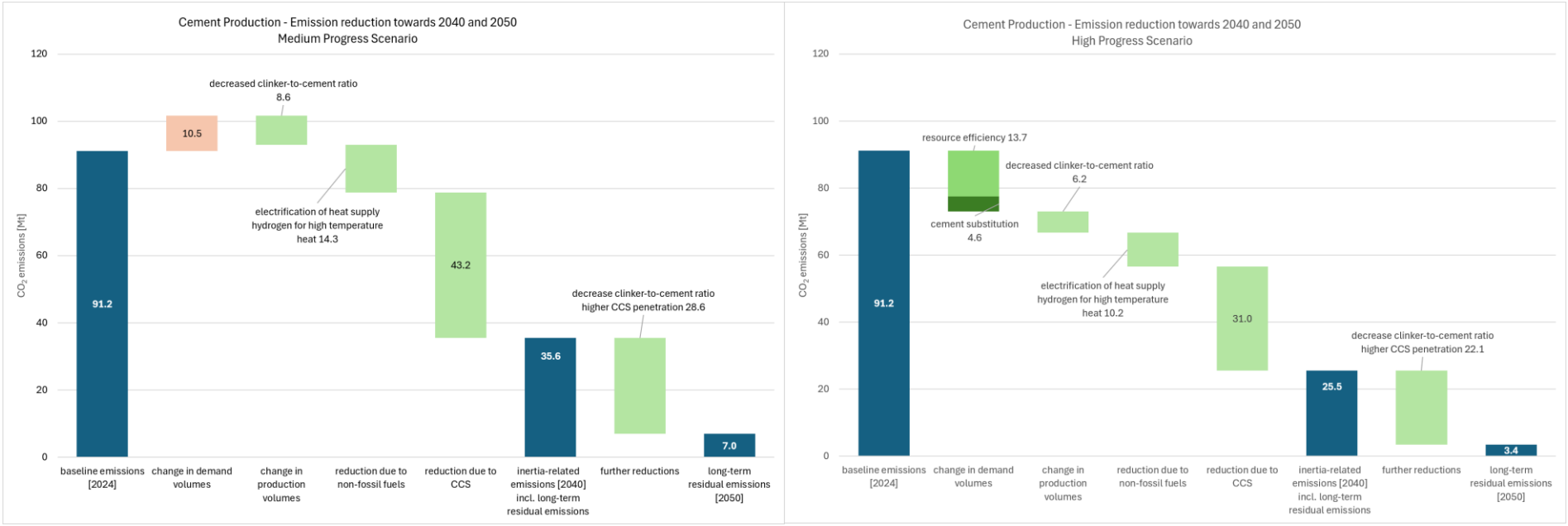
clinker-to-cement-ratio to 50% (New Climate Institute 2020). We assume that the production of alternative SCMs does not generate substantial additional emissions suggesting that heat is generated by carbon-neutral sources and that emissions from traditional SCMs are accounted for in the respective industries. Starting from a fossil fuel share of 76% for energy-related emissions from heat supply, in 2024, we assume the share to decrease to 30% by 2040 following assumptions from New Climate Institute (2020) and 0% by 2050. In both scenarios the share of plants connected to the CCS infrastructure is 75% in 2040 and 100% in 2050.

Table 5-4: Cement - Scenarios

	Year	Medium-progress scenario	High-progress scenario	Source, if not mentioned in text above
Cement production	2024	161.0	161.0	Eurostat PRDCOM
	2040	179.5	128.8	Bellona (2025), EC (2024b)
	2050	198.0	96.6	Bellona (2025), EC (2024b)
CO_2 emissions absolute [Mt CO_2]	2024	91.2	91.2	
	2040	35.6	25.5	
	2050	7.0	3.4	
CO_2 emissions intensity [tCO2/t cement]	2024	0.6	0.6	
	2040	0.1	0.3	
	2050	0.0	0.0	

Source: Oeko-Institut

Quantitative results



The analysis shows that different measures can be applied to reduce the cement sector's emissions. Depending on ambitions and measures, residual emissions can be reduced to as low as 3.4 $MtCO_2/a$ in the high-progress scenario. The high-progress scenario is based on ambitious assumptions regarding resource efficiency, cement substitution, a decrease in production and a lower clinker-to-cement ratio (Bellona 2025). However, also in the medium-progress scenario, which evidenced higher emissions based on an increase in production, emissions can be reduced to a minimum of 7.0 $MtCO_2/a$.

5.5 Aviation and maritime transport

Sector overview

153 Mt CO_2 emissions in 2024[13]	**N/A** share of sector emissions in total EU-ETS1 Industry 2024	**334** airlines **3,140** shipping companies in EU-ETS1 respectively in 2024	Average emissions per installation: **n/a** range: **n/a**	**0%** process-related emissions today

Source: 2024 emissions data from EEA (2026a), numbers of EU-ETS1 -covered entities taken from Union registry as of 12.10.2026: https://union-registry-data.ec.europa.eu/report/welcome

As of 2026, the EU-ETS1 scope covers domestic and intra-EEA aviation, domestic and intra-EEA maritime transport and 50% of arriving and departing EEA maritime transport. Due to the ongoing revision of the EU-ETS1, the scope for international transport might be extended. The aviation scope might include all departing flights to airports within 5000km from Frankfurt starting in 2029 – estimated to add approx. 20 Mt CO_2 to the current scope.[14] It is also proposed to extend the EU-ETS1 to smaller emitters (business flights) which would add less than 1 Mt of emissions.[15] The scope of maritime transport might be extended to cover certain types of small ships (except for passenger ships) which would add about 9.54 Mt CO_2 emissions.[16] These potential extensions are not reflected within this study.

Today, the aviation and maritime sectors are dominated by combustion of fossil fuels in turbines (aviation) and internal combustion engines (maritime). In the maritime sector, there is a small but increasing share of alternative fuels. In addition, electrification of ferries can be observed.

In aviation, CO_2 emissions occur during combustion of fossil kerosene. In maritime transport, CO_2, CH_4 and N_2O emissions occur from the combustion of fossil fuels. The fuel mix today is mainly dominated by heavy fuel oils (HFO) / very low sulphur fuel oil (VLSFO) and smaller shares of LNG. Slippage of methane is relevant when ships use LNG instead of HVO. For maritime transport, the EU-ETS1 not only covers CO_2 emissions but also CH_4 and N_2O emissions from 2026 onwards. Emissions from domestic aviation and maritime accounts only for a small share of EU-ETS1 relevant emissions and could be replaced by surface transport or electrified transport options.

[13] This number presents total verified emissions within the EU-ETS1 scope for aviation and maritime. However, in 2024 the phase-in for maritime transport still applied and shipping companies only needed to surrender allowances for 40% of verified emissions resulting in 35.6 million allowances for maritime transport. As of 2026, shipping companies need to surrender allowances for 100% of the emissions covered by the EU-ETS1, thus we show the totals here. https://climate.ec.europa.eu/document/download/ddc1b1de-652b-49ed-8f15-d9fa8badd39f_en?filename=com_2025_735_en.pdf

[14] For example, estimates from: T&E: https://www.transportenvironment.org/articles/eu-takes-half-hearted-step-towards-taxing-international-flights; ICCT: https://theicct.org/publication/aviation-carbon-leakage-risks-under-an-expanded-eu-emissions-trading-system-jul26/

[15] Table 21 in https://climate.ec.europa.eu/document/download/63c0103a-6b5f-4151-b117-b3c4b35b5d0e_en?filename=swd_2026_616_part_3_en.pdf

[16] EC (2026) – Impact assessment, part 3: https://climate.ec.europa.eu/publications/swd2026-616-impact-assessment_en

Other climate-relevant emissions in aviation stem at two thirds from non-CO_2 effects (including contrails) which are currently not subject to the EU-ETS1 (although there is measurement, reporting and verification (MRV) for intra-EEA flights).

Abatement options

For aviation the main option to mitigate emissions is the use of SAF, where e-SAF is the most promising options as it is more scalable than bio-SAF where limited availability of sustainable biomass feedstocks must be considered. Smaller shares of hydrogen and electric aircrafts are expected by 2050. (EC 2024b, figure 75)

For maritime transport the main technologies for 1/3 of the fleet are battery-electric and fuel cells. The other 2/3 of the fleet will have to use alternative sustainable fuels (mainly e-ammonia and e-methanol, but also biodiesel and in some cases also bio-or synthetic LNG). (EC 2024b, figure 73 and 74)

A modal shift towards rail and electrified transport modes can reduce fossil fuel demand in maritime transport and aviation.

Demand reduction / reduced increase of activity can also be achieved due to digital substitution of business trips and less distances travelled. Generally, higher ticket prices or freight rates due to energy tax, VAT, and carbon pricing through EU-ETS1 or national levies can also reduce demand if the price increase is passed through to end customers (CE Delft 2026).

Energy efficiency gains can be achieved in aviation based on re-routing and more efficient airplanes. For maritime transport energy efficiency measures such as wind-assisted propulsion (WASP) (Seas at Risk 2025) and other technical efficiency measures (like air lubrication) are available.

Remaining emissions in the minimal emission scenario still stem from consumption of fossil fuels mainly in aviation (EC 2024b).

Options for carbon capture and storage are discussed for maritime transport, where CCS onboard is discussed. However, this technology is not yet available at large scale and is unlikely to be significantly used until 2050.

Requirements to reach minimal residual emissions

The requirements to reach the level of minimal residual emissions are:

- Upscaling of sustainable alternative fuel production (especially in the EU), especially e-SAF for aviation and mainly e-ammonia and e-methanol for maritime transport
- Low-carbon onshore power supply for ships in ports
- Price gap reduction between fossil and sustainable fuels through
  - upscaling of production,
  - pricing fossil fuels through EU-ETS1, energy tax on fossil fuels and
  - support mechanisms and funding of sustainable fuels

Scenario definition

For the medium-progress scenario, we use data from the LIFE scenario of the Impact Assessment (EC 2024b). For the high-progress scenario, we use data from the LIFE scenario until 2040, however, assume a 100% share of e-fuels (including methanol, ammonia, biomass and e-SAF) for 2050 as there is no technical need to use fossil fuels.

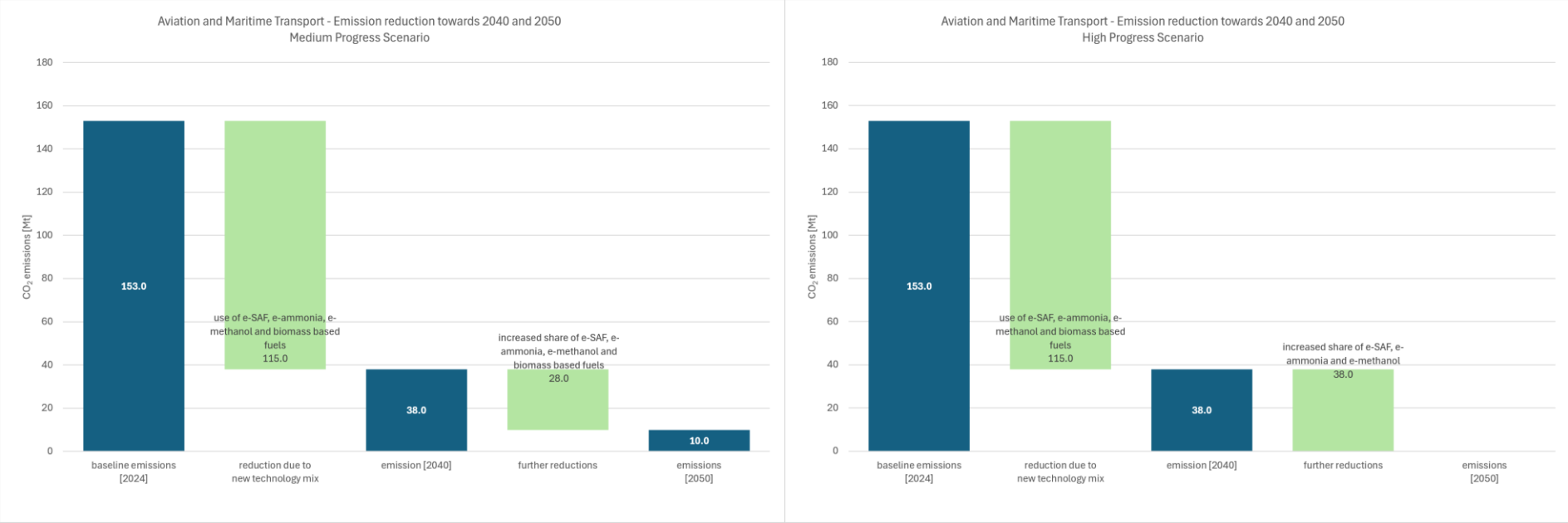
Table 5-5: Maritime transport and aviation - Scenarios

	Year	Medium-progress scenario	High-progress scenario	Source
Transport demand	Passenger transport	Aviation: ~42% increase from 2015 to 2040		EC (2024b, Figure 61 and 63)
	Freight transport	Domestic maritime transport: ~43% increase from 2015 to 2040 International navigation: ~33% increase from 2015 to 2040		
Energy consumption [Mt_{oe}]	2015	34.7	34.7	EC (2024b, Figure 64)
	2040	41.0	40.3	
	2050	43.6	41.7	
CO_2 emissions absolute[17] [Mt]	2024	153	153	EEA (2026a)
	2040	41	38	EC (2024b, Table 3)
	2050	11	10	
Implied emission factor [$MtCO_2/Mt_{oe}$]	2015	3.1	3.1	Authors' own calculation
	2040	1.0	0.9[18]	
	2050	0.3	0.2[19]	

Source: Oeko-Institut

[17] Only CO_2 emissions from fossil fuels, not from burning for example e-SAF.
[18] Implies roughly 66% fossil emission-free efuels or biofuel
[19] Implies over 90% fossil emission-free efuel or biofuel

Quantitative results



Aviation and maritime transport are expected to increase activity. The central abatement option is the use of e-SAF, e-ammonia and e-methanol. Remaining emissions in 2040 are ~25% of today's emissions. The medium-progress scenario assumes emissions in 2050 to remain at ~10 Mt CO_2. As there is no technical reason to not increase the share of e-fuels further, the long-term residual emissions in the high-progress scenario are reduced to zero for 2050.

5.6 Waste incineration

Sector overview

53 Mt CO_2 emissions in 2024	**n/a** share of sector emissions in total EU-ETS1 Industry 2024	**>600** installations in EU-ETS1	Average emissions per installation: **n/a**	**0%** process-related emissions today

Source: Authors' own calculations

Waste incineration plants burn waste and generate heat or electricity. There are various types of technologies used in incineration plants, however, they have no influence on emissions. Only plants whose main purpose is waste treatment are considered, so facilities such as cement plants are excluded. Based on the available data, it is assumed that there are more than 600 waste incineration plants in Europe. The median annual waste intake capacity of waste incineration plants listed in (listed in CEWEP (2025)) is approximately 142,000 tonnes per year, though plant capacities vary widely. CO_2 emissions from waste incineration stem primarily from the oxidation of carbon contained in the waste stream. Additional CO_2 emissions originate from the use of auxiliary fuels, typically natural gas or fuel oil. In German incineration facilities this value accounts for ~3 % of the total fossil CO_2 emissions (Deutsche Emissionshandelsstelle (DEHSt) 2026).

Abatement options

Abatement options in the waste management sector target the **reduction of waste volume** generated and ultimately sent to incineration. This can be achieved through a broad mix of policy instruments, economic incentives, and product-related measures. One example are intelligent product design approaches such as *design for recycling* that can facilitate material recycling instead of incineration at the end of a product's life. Also, extension or introduction of Extended Producer Responsibility (EPR) schemes can support this shift by creating financial incentives for producers to minimise waste generation and improve recyclability. Other instruments include minimum recycled-content requirements, higher recycling and separate collection targets, restrictions on single-use plastics, and obligations to use reusable rather than disposable packaging. Another more technical approach is the improvement of the sorting process prior to the incineration of waste. One such strategy involves the establishment of pre-sorting facilities in proximity to waste incineration plants, with the objective of extracting especially plastics e.g. three-dimensional plastics prior to their entry into the incineration process. Instead of being incinerated, these separated materials can be sent for recycling, which reduces the volume of waste being incinerated. Taken together, these measures can substantially reduce the amount of waste directed to incineration and, as a result, lower overall emissions.

For the CCS pathway, it is assumed that by 2040, all plants with a capacity exceeding the third quartile of all EU plants (i.e. 251 kt/a) will be equipped with CCS, based on plant capacity data from CEWEP (2024). By 2050, this is extended further, with all plants above the EU median capacity (i.e. 143 kt/a) assumed to have CCS in place, again based on

capacity data from CEWEP. For CCS, a capture efficiency of 85% was assumed (IEAGHG 2020; Bisinella et al. 2021; Herraiz et al. 2026).

Requirements to reach minimal residual emissions

Achieving the level of **minimal residual emissions** from waste incineration depends on the simultaneous fulfilment of multiple conditions:

- It is necessary to reduce the overall volume of waste significantly. This can be achieved through a reduction in demand, whether through the utilisation of alternatives or broader degrowth trends, as well as through enhanced circularity and recycling practices that extend the life of materials.
- The amount of plastic that is incinerated must be significantly reduced and recycled instead, since plastic combustion is a major source of emissions in the waste sector.
- CCS technology needs to be both available and cost-effective for waste incineration plants. This also requires that plant operators are willing to pay the higher costs associated with adopting CCS.
- The energy output lost from the plant when CCS is applied at waste-to-energy plants, both electricity and heat, needs to be replaced with renewable energy generation, so that the shift to lower emissions does not come at the cost of reducing the overall energy supply.

Scenario definition

In the medium-progress scenario, waste volumes increase over the coming years when the forecast is based on the average growth rates of recent years. In the high-progress scenario, a decrease in waste volumes is assumed, caused among other by a reduction in plastics in incineration due to political measures. This reduction is accompanied by a change in waste composition, which in turn alters the emission factor. Currently, there are hardly any waste incineration plants with CCS, with existing cases limited to pilot stage or planning. Looking ahead, it is expected that by 2040, 25% of plants will be connected to CCS, and by 2050, 75%. In the medium-progress scenario, emissions increase, while in the high-progress scenario they decrease (both without CCS); however, CCS can reduce emissions in both scenarios. In both scenarios, emission factors and emissions are calculated and evaluated separately for biogenic and fossil sources.

In the medium-progress scenario, waste volumes are forecast based on the average annual growth rates observed between 2004 and 2022. For example, in Belgium, waste quantities increased by 0.8% per year over this period, and this growth rate is extrapolated forward to project future volumes. The underlying data comes from Eurostat (2025) (env_wastrt), covering waste management options D10 and R1 (total waste) for the years 2004 to 2022, the most recent year currently available on Eurostat. In addition, Eurostat data on waste composition (covering both municipal waste and other waste streams) is used to characterise the waste going into incineration. Emissions are then calculated by combining specific emission factors (split into fossil

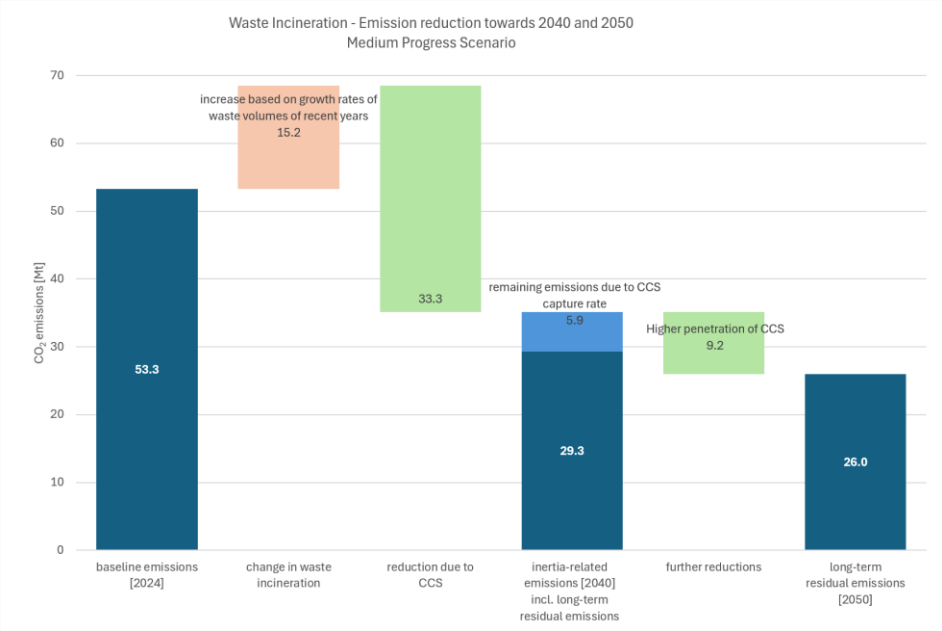
and biogenic emissions) (Doka 2020; EBeV 2030 2022; IPCC 2006) with waste composition and waste volumes.

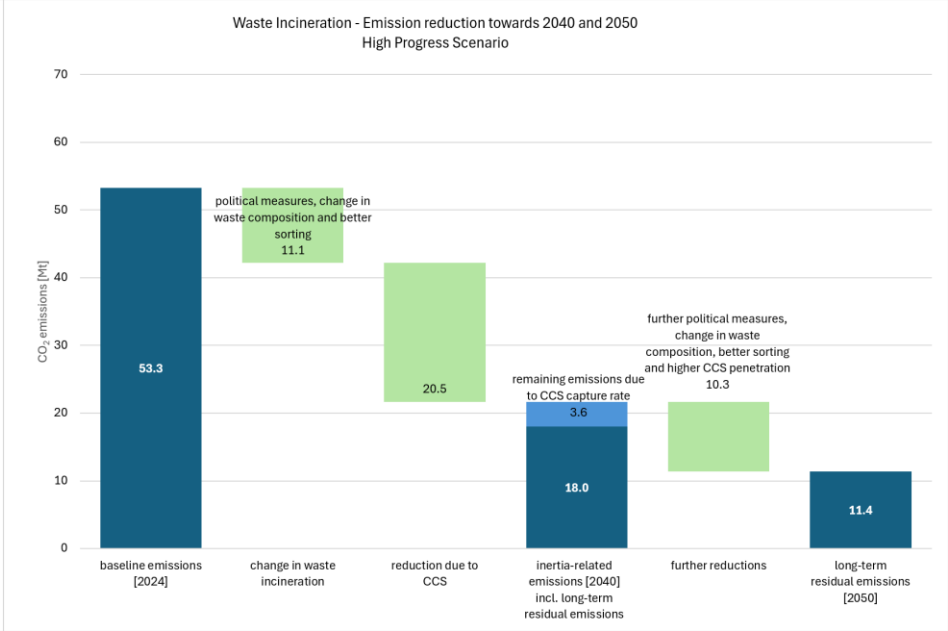
For Germany, which has the highest volume of waste sent to incineration, data on fossil and biogenic CO_2 emissions are available from DEHSt (German Emissions Trading Authority) (Deutsche Emissionshandelsstelle (DEHSt) im Umweltbundesamt 2026). These reported emissions are around one third lower than the emissions estimated on the basis of Eurostat data on waste volumes and composition. The main reason is that not all waste classified as incinerated is treated in plants covered under the relevant scope. The installations included are waste incineration plants, biomass combustion plants, and sewage sludge incinerators. However, waste is also co-incinerated in other facilities, such as industrial plants, cement kilns, and lignite-fired power plants, where the associated emissions are accounted for in other sectors. This is particularly relevant in Germany, where co-incineration in coal power plants and cement kilns plays a larger role than in most other EU countries. To reflect this, a correction factor of 70% (fossil) and 76 % (biogenic) is applied to the waste volumes sent to incineration in Germany, whereas a more conservative factor of 75% is used for all other countries.

In the high-progress scenario rough estimates are used. For plastics, glass, and mixed waste, the amount incinerated is assumed to decline by 50% by 2040 and by 80% by 2050. For paper and cardboard, a smaller reduction is assumed, at 20% by 2040 and 40% by 2050. Sorting residues are expected to decrease by 35% by 2040 and 50% by 2050, due to technological advancement (e.g. better sorting yields and higher recycling yields). Common sludge follows the opposite trend, as larger quantities are expected to be incinerated in the future. This stream is therefore assumed to increase by 50% by 2040 and by 100% by 2050. Taken together, these developments lead to an overall reduction in the total amount of waste incinerated. At the same time, the composition of waste changes, which in turn results in different emission factors compared to the medium-progress scenario.

CO_2 emissions that can be captured by CCS were estimated by first multiplying the number of plants equipped with CCS by the capture capacity of each plant. This value was then divided by the total capacity of all plants to derive the share of overall capacity covered by CCS. On this basis, CCS covers 57% of total capacity in 2040, increasing to 81% in 2050. These shares were then applied to total emissions to estimate the volume of CO_2 that can be captured.

Quantitative results





The medium-progress and high-progress scenario mainly differ in the volumes of waste incineration. The medium-progress scenario shows higher volumes and therefore emissions are not reduced until 2040 and 2050 as much as in the high-progress scenario. Both scenarios depend on CCS which cannot be applied to all installations due to delayed connection to the CCS infrastructure or installations of small size where CCS remains unlikely in the long term.

5.7 Bulk chemicals

Sector overview

31.4 Mt CO_2 emissions in 2024	**7.9%** share of sector emissions in total EU-ETS1 Industry 2024	**269** installations in EU-ETS1	Average emissions per installation: **0.12 Mt CO_2/a** range: **0.0 – 3.31 Mt CO_2/a**	**0-5%** process-related emissions today

Source: 2024 data from EEA (2026a)

The bulk chemicals sector is a highly complex sector with interrelated production processes that are regularly co-optimised in their energy streams. For our assessment we select two groups of basic high value chemicals (HVCs) that are broadly used in different applications and further processed to more complex and derived products: olefins, and aromatics. Current major production routes in the EEA include steam crackers based on naphtha, ethane, or butane/propane/LPG. In a steam cracking process hydrocarbon inputs are broken down into a mix of olefins and aromatics. CO_2 emissions occur primarily during high-temperature steam cracking and feedstock conversion, where fossil fuels serve as both an energy source for high-temperature heat and a carbon feedstock. Electricity for driving compressors and pumps is a second major energy input that comes with indirect emissions. In China methanol-to-olefins (MTO) is also broadly applied. The processes differ substantially in their underlying process chemistry, the required energy inputs and typical yields of the respective HVCs. While naphtha cracking always yields a mix of ethylene, propylene and aromatics, ethane-based cracking yields ethylene with very small shares of propylene and no aromatics. Depending on the catalysts employed, the MTO route can yield different splits of ethylene and propylene but does not yield aromatics either. This makes a straightforward substitution of one route by the other impossible and requires a more in-depth assessment of the respective HVC categories.

For a further assessment, we define three sub-sectors: olefins production, aromatics production and other processes, and attribute all emissions currently reported under activity code 42 to one of these three.

Olefins

In the EEA, olefins are currently mainly produced via steam cracking of naphtha. Typical naphtha crackers emit approximately 0.8–1.4 tonnes of CO_2 per tonne of high-value chemicals (Linde 2024). Recently, the share of ethane-based crackers has increased, and new investments into cracking capacity, such as INEOS One Project in Antwerp (Ineos 2025), rely on ethane as input. Among other factors, this is due to the lower specific emissions, with typical ethane crackers emitting approximately 0.4–0.7 tonnes of CO_2 per tonne of ethylene (Linde 2024), and to the increased availability of ethane from fracking-based natural gas production (Gardiner 2021). Smaller amounts are also produced from other hydrocarbons (propane/butane/LPG) also using steam crackers. Based on the mix of routes in 2016/2017, the average emission intensity was 0.849 tCO_2/t HVC (EU-ETS1 Benchmark). Assuming marginal progress in energy efficiency and

based on a total production of 25.7 Mt ethylene and propylene from steam cracking (Petrochemicals Europe 2023) we attribute 21.5 $MtCO_2$ to olefins production in 2024.

Aromatics

Aromatics are mainly produced through two established pathways. In refineries, naphtha is heated and converted in a catalytic reformer, an energy-intensive process that produces an aromatic-rich stream from which the target products are extracted and purified. Alternatively, aromatics are recovered from pyrolysis gasoline, a by-product of steam cracking, where feedstocks are heated to very high temperatures; this furnace heat is the main source of direct CO_2 emissions. The pyrolysis gasoline is subsequently treated with hydrogen before extraction, with additional emissions arising mainly from the energy and upstream production required to supply the hydrogen. Smaller process-related emissions may occur during catalyst regeneration, cracker decoking and flaring. These are hardly relevant when transformation towards minimal emission pathways has taken place. Based on the mix of routes in 2016/2017, average emissions intensity was 0.878 tCO_2/t HVC (EU-ETS1 Benchmark). Based on the share of Benzene from naphtha in total Benzene production in 2024 (57%, Petrochemicals Europe 2023) and total aromatics production of 11.9 Mt in the EU27 in 2024 (Eurostat 2026) we attribute 6.0 $MtCO_2$ to aromatics production for 2024.

Other processes

Emissions from other processes are calculated by subtracting emissions for olefins and aromatics production from total bulk chemicals production. This yields 3.6 $MtCO_2$ in 2024.

Abatement options

Options to reach the level of minimal emissions based on DECHEMA (2017) are the following:

- Olefins
  - Via hydrogen-based methanol on the MTO-route
  - Biomass-based conversion
- Aromatics
  - Via hydrogen-based methanol on the MTO-route
- Other processes
  - Electric steam generation and steam recompression

Other options mentioned are electricity-based steam crackers (e-crackers) like the ones piloted by BASF (BASF 2024), however they still rely on traditional hydrocarbons as the main raw material input.

Requirements to reach minimal residual emissions

The top three requirements to reach the level of minimal residual emissions are:

- Large-scale availability of low-cost renewable hydrogen

  - Renewable energy uptake for renewable hydrogen production
  - Investment in large-scale electrolysis capacities
  - Investment in large-scale hydrogen transport infrastructure if relocation of current site is to be avoided
- Sustainable and climate-neutral CO_2 sources for synthetic methanol production
- Large amounts of renewable electricity for alternative heat supply

Scenario definition

Olefins

The share of naphtha as a feedstock for olefins production was about 67%, further 19% used propane/butane/LPG, ethane had a share of 9%, and 6% came from other sources in 2024 (Petrochemicals Europe 2023). Following the ambitious Maximum scenario (DECHEMA 2017), we assume that the share of the MTO-route increases to 50% by 2040 and 85% by 2050. In 2040, biomass-based olefins will have a share of 5%. The rest splits equally between legacy naphtha-based crackers and ethane-based crackers. This implies a relative increase in the share of ethane-based crackers which is in line with the current construction pipeline. We assume that one-third of the crackers are equipped with carbon capture and that about 60% of the gas streams are directed towards the capture unit. We assume that the fossil naphtha-based crackers have a specific emission factor of 0.85 tCO_2/t olefins, with those units equipped with CCS having an emission factor of 0.39 tCO_2/t olefins. For ethane-based crackers we assume 0.68 tCO_2/t olefins without carbon capture, and 0.31 tCO_2/t olefins with carbon capture installed. Using these assumptions, the average emissions intensity drops to 0.25tCO_2/t olefins.

Following the same scenario, the share of the MTO-route increases to 85% by 2050, while 15% are biomass-based olefins.

In terms of production volumes, we establish two scenarios: one scenario with a moderate decrease in production of 3% by 2040, and 7% by 2050, as implied by the trend of ethylene production in the STD scenario of the EC 2040 Impact Assessment (EC 2024b). The other scenario assumes a more pronounced decrease of 20% by 2040, and 28% by 2050, as implied by the CIRC scenario of the EC 2040 Impact Assessment (EC 2024b). We account for the fact that currently significant shares of propylene are produced from other sources than traditional steam crackers (Petrochemicals Europe 2023), summing up to 3.9 Mt in 2024. When we develop the production scenarios, we assume that these amounts are also produced by the bulk chemical sector.

Aromatics

We estimate the share of naphtha as a feedstock for aromatics production using the share of benzene from steam crackers vs. from refineries in 2024 (Petrochemicals Europe 2023), which was about 57%. Following the ambitious Maximum scenario (DECHEMA 2017), we assume that the share of the MTA-route increases to 45% by 2040 and 100% by 2050. In 2040, the remaining production (55%) splits between refineries, with about 30% of production, and fossil naphtha-based crackers. We assume that one-

third of the crackers are equipped with carbon capture and that about 60% of the gas streams are directed towards the capture unit. We assume that the fossil naphtha-based crackers equipped with CCS have an emission factor of 0.45 tCO_2/tBTX. Using these assumptions, the average emissions intensity drops to 0.18 tCO_2/tBTX. Following the same scenario, the share of the MTA-route increases to 100% by 2050.

In terms of production volumes, we assume the pathway for petrochemicals in the S3 scenario of the EC 2040 Impact Assessment (2024) for our medium-progress scenario and the LIFE scenario pathway for our high-progress scenario.

Other processes

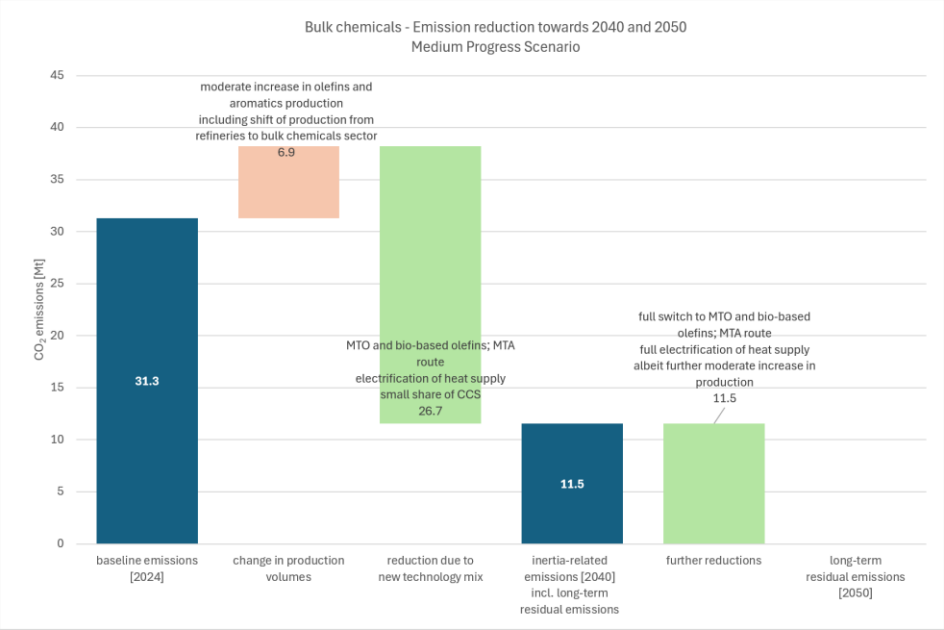
Following the ambitious Maximum scenario (DECHEMA 2017) we assume that 50% of electric steam generation and steam recompression is electrified by 2040, and 100% by 2050.

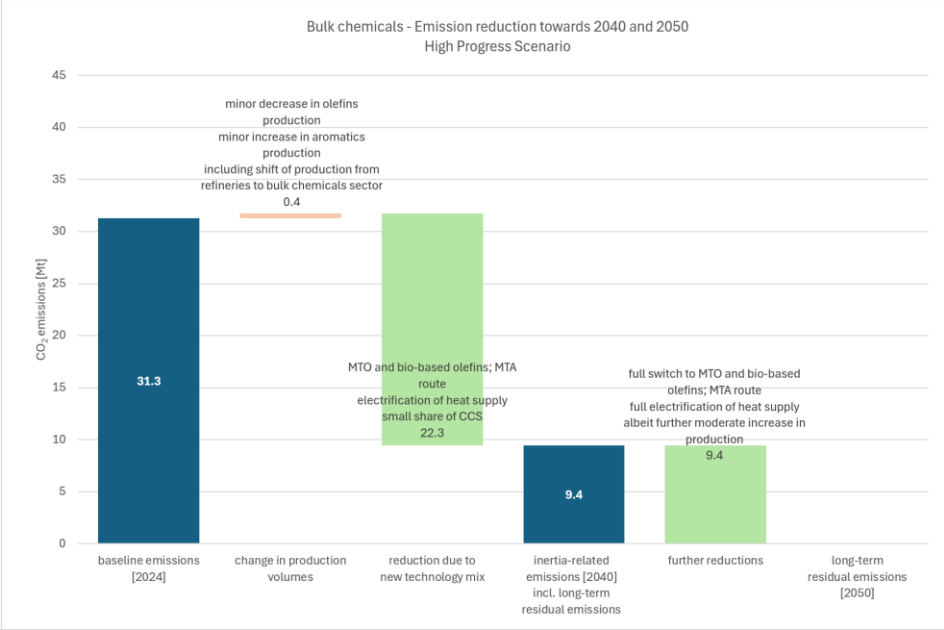
Table 5-6: Bulk chemicals - Scenarios

	Year	Medium-progress scenario	High-progress scenario	Source
Production of olefins	2024	25.7	25.7	
	2040	30.8	25.3	EC (2024b)
	2050	29.6	22.8	EC (2024b)
Production of aromatics	2024	6.8	6.8	
	2040	9.7	7.6	EC (2024b)
	2050	14.3	9.0	EC (2024b)
CO_2 emissions absolute [$MtCO_2$]	2024	31.3	31.3	
	2040	11.5	9.4	
	2050	-	-	

Source: Oeko-Institut

Quantitative results





In the transition phase until 2050, changes in production have a significant impact on remaining emissions, as illustrated by the two production pathways. Once production routes are changed to hydrogen-based methanol there are no direct emissions associated with bulk chemical production.

5.8 Lime

Sector overview







21.5 Mt CO_2 emissions in 2024	**4.8%** share of sector emissions in total EU-ETS1 Industry 2024	**198** installations in EU-ETS1	Average emissions per installation: **0.11 Mt CO_2/a** range: **0.0 – 1.79 Mt CO_2/a**	**66%** process-related emissions today

Source: 2024 data from EEA (2026a)

The main source of emissions of lime production is the calcination of lime. Through high temperatures CO_2 is extracted from limestone ($CaCO_3$) and emitted into the atmosphere. Remaining emissions stem from coal and natural gas-fired kilns that are needed to reach these high temperatures. The ratio of process-related to energy-related emissions amounts to 66% to 33%. As the largest share of emissions are process-related emissions, the application of CCS is one of the most important measures to reduce sector emissions. Energy-related emissions can be reduced through the application of non-fossil fuels or renewable electricity. However, the current TRL of electricity-based high-temperature processes is not sufficient to implement them at large scale (kei 2026).

Abatement options

CCS can be implemented at around 70% of production sites and is considered one of the central decarbonisation options to address process emissions. Roughly 30% of the production sites are assumed to be too small for CCS to be applied by 2040. It is unclear if decentralised CCS technologies will be developed to an extent that they can be applied to mitigate remaining emissions. Beyond that, electricity-based and hydrogen-based technologies in kilns can be applied to decarbonise energy-related emissions.

Requirements to reach minimal residual emissions

The top three requirements to reach the level of minimal residual emissions are:

- CCS infrastructure expansion is necessary, therefore the technology readiness of CCS needs to be increased so that practical application becomes viable.
- Renewable expansion and carbon neutral fuels are needed for decarbonisation.
- Material efficiency needs to be exploited through regulation, meaning that the necessary lime input in products should be reconsidered.

Scenario definition

The medium-progress and high-progress scenario are defined by the same technological configuration: An increase of connection of eligible plants to the CCS infrastructure and the roll-out of electricity-based kilns and renewable energy carriers to fire conventional kilns are the main measures to mitigate energy-related emissions. The difference between the scenarios is the reduction of production in the high-progress scenario, which assumes material efficiency in the building sector leading to a decrease

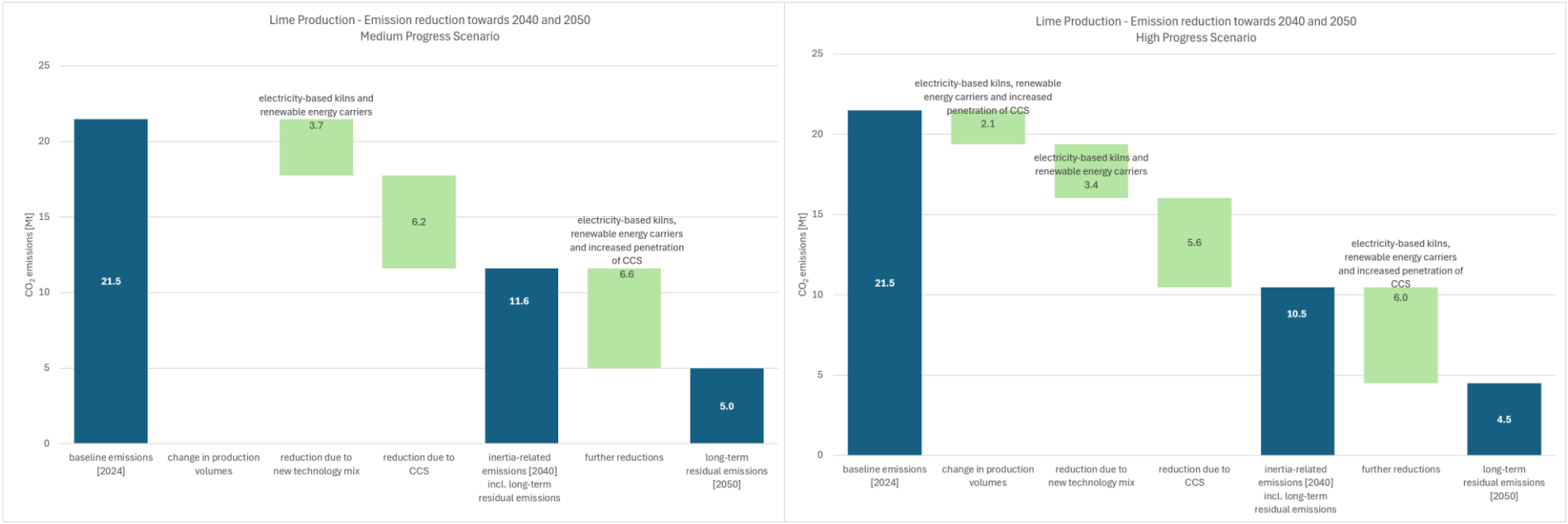
in demand of 5%. This number is taken from the high-progress scenario of the cement sector due to the lack of lime-specific literature.

Table 5-7: Lime - Scenarios

	Year	Medium-progress scenario	High-progress scenario	Source
Production (primary and secondary) [Mt]	2024	20.4	20.4	
	2040	20.4	19.4	European Lime Association (2019)
	2050	20.4	18.4	European Lime Association (2019)
CO_2 emissions absolute [Mt]	2024	21.5	21.5	
	2040	11.6	10.5	
	2050	5.0	4.5	
CO_2 specific emissions **[tCO_2/t]**	2024	1.05	1.05	
	2040	0.57	0.54	
	2050	0.24	0.24	

Source: Oeko-Institut

Quantitative results



The results show that a decrease in production through resource efficiency measures in the high-progress scenario leads to the a priori mitigation of emissions. As CCS is assumed to be able to capture only a share of process emissions, the residual emissions in the medium-progress scenario are higher than in the high-progress scenario in which less process emissions need to be mitigated.

5.9 Paper

Sector overview

18 Mt CO_2 emissions in 2024	**4.1%** share of sector emissions in total EU-ETS1 Industry 2024	**139 (pulp)** **453 (paper)** installations in EU-ETS1	Average emissions per installation: **0.03 Mt CO_2/a** range: **0.0 – 0.36 Mt CO_2/a**	**0%** process-related emissions today

Source: 2024 data from EEA (2026a)

The production of pulp can be based on virgin fibre (wood) or recovered fibre (recycling). Mechanical pulping needs electricity while the more common chemical pulping process needs thermal energy. Chemical production of pulp results in black liquor, a by-product rich in lignin, cellulose and chemicals, which needs to be heat-treated to concentrate and is then burnt. The production of paper needs mechanical energy for pressing in the paper machine as well as thermal energy for drying. The production of pulp and paper today relies at 60% on energy input from biomass, 26% natural gas and 10% purchased electricity (JRC 2026b). This high share of biomass (especially in the pulp production) stems from burning residuals of the wood feedstock as well as burning concentrated by-products from the chemical pulp production.

Direct emissions are emitted from burning fossil fuels to generate heat and electricity at the installations. Further emissions occur in the recycling of chemicals: burning the remaining calcium carbonate results in calcium oxide and CO_2. However, the CO_2 stems from the wood feedstock and can be considered a biogenetic CO_2 source. Indirect emissions can be a result of the purchase of electricity.

CCS is not a relevant decarbonisation option for the pulp and paper industry. Emissions are energy-related and can be abated by electrification and fuel switch.

Abatement options

The literature covers several abatement options for the paper and pulp sector. Decarbonising the heat production is a major lever to reduce emissions. Most of the heat demand can be covered by electrified heat production via high temperature heat pumps or electrode boilers. Some remaining high-temperature demands might be covered by hydrogen-based burners or burning biomass. Another option is to increase the recycling of paper and cardboard as recycling of paper is less energy-intensive. The energy efficiency of paper plants can be increased especially by making use of heat recovery. (JRC 2026b; FfE 2019b)

Requirements to reach minimal residual emissions

The requirements to reach the level of minimal residual emissions are:

- Availability of renewable electricity for electrification of process heat
- Improvements of electrical high-temperature technologies
- Increase of recycling shares and improvement of collection-process of paper

Scenario definition

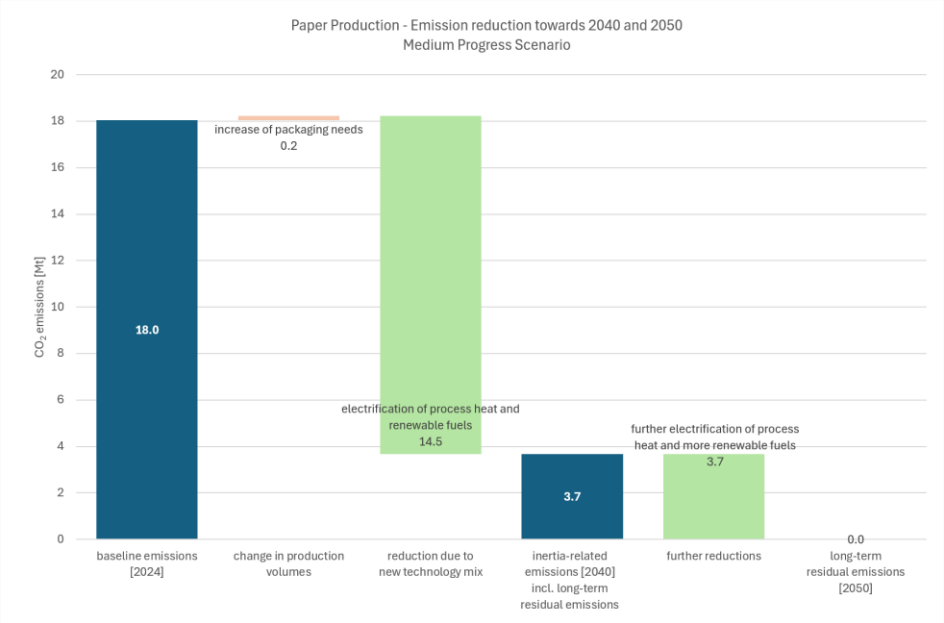
We based the medium-progress scenario on the S3 scenario of the European Commission's Impact assessment (EC 2024b). This scenario assumes a 5% increase in paper and cardboard production due to packaging needs as more consumer goods are ordered online and transported via mail. The high-progress scenario is based on the LIFE scenario, which assumes 20% less paper and 40% less pulp production. Assumptions leading to this decrease in demand are higher recycling rates (starting from ~60% today (CEPI 2026)), reuse of packaging and increased material efficiency. A switch to electrification and renewable fuels reduces the CO_2 emissions until 2040 drastically.

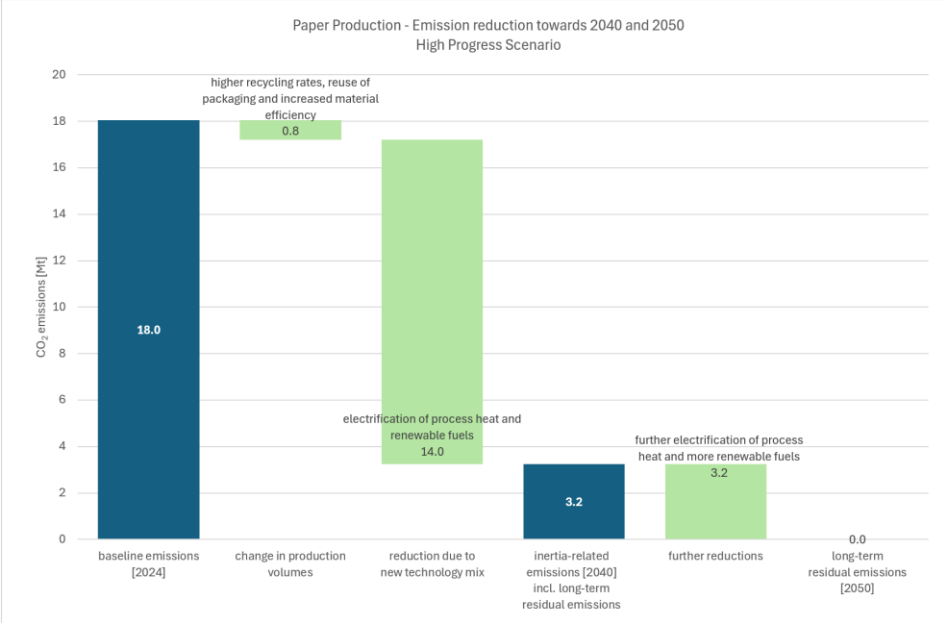
Table 5-8: Paper and Pulp - Scenarios

	Year	Medium-progress scenario	High-progress scenario
Production of pulp [Mt]	2024	33.7	33.7
	2040	34.3	28.5
	2050	35.4	20.2
Production of paper [Mt]	2024	78.7	78.7
	2040	80.2	72.6
	2050	82.6	63.0
CO_2 emissions absolute [Mt]	2024	18.0	18.0
	2040	3.7	3.2
	2050	0.0	0.0

Source: Oeko-Institut

Quantitative results





The two scenarios show a difference in production volumes. However, the main emission reduction effect stems from electrification of process heat in both scenarios. Remaining emissions in 2040 occur due to slow uptake of high-temperature heat technologies. Long-term residual emissions are zero as there are no reported emissions that cannot be abated in the long term.

5.10 Glass

Sector overview

14.3 Mt CO_2 emissions in 2024	**3.2%** share of sector emissions in total EU-ETS1 Industry 2024	**293** installations in EU-ETS1	Average emissions per installation: **0.05 Mt CO_2/a** range: **0.0 – 0.33 Mt CO_2/a**	**20-25%** process-related emissions today

Source: 2024 data from EEA (2026a)

The glass sector consists of container glass, flat glass and specialty glass production. Glass production is based on melting raw materials and cullage (broken glass shards) so that it can be reformed to the desired shape. Currently, ovens are natural gas-based, which leads to energy-related emissions. Process-related emissions originate from heating raw materials. Electricity plays a minor role in glass melting and is mainly applied for preheating recycled glass. Completely electric ovens are only used in case of small tonnages, which is mostly the case in specialty glass manufacturing (FEVE 2026; GfE 2025).

Energy-related emissions that are emitted from natural gas combustion to melt down the raw material-cullage-mix amount to 80% of emissions from the container glass and 75% of emissions from the flat glass industry. Process-related emissions result from heating and melting the raw materials and amount to 20% and 25% respectively (GfE 2025; FEVE 2026).

Abatement options

Regarding the energy-related emissions, the substitution of natural gas as well as the exploitation of electrification potentials are central levers of decarbonisation. The glass sector will apply different abatement options that range from complete electrification to hybrid melting with electricity and hydrogen. As a prerequisite, renewable hydrogen and renewable electricity need to be available in sufficient quantities (FEVE 2026). For example, the electrification of large furnaces with a daily production of over 700t is deemed not economically feasible due to high efficiency losses (BV Glas 2022).

Beyond this R&D should address insufficient TRL of electricity-based solutions in large-scale melting ovens to reduce efficiency losses. An increase of recycling rates and thereby increasing the use of cullage can reduce energy consumption as well as process emissions as it melts at lower temperatures and replaces raw materials. An open question is, how strongly raw materials can be substituted, as melting glass shards bear a risk of contamination of electrodes on the bottom of the melting basin/pot (FEVE 2026; GfE 2025).

The increase of cullage is an important measure in both the container glass and the flat glass sector. In both recycling of broken glass is a central measure to avoid emissions from raw materials. Over time the industry plans to expand the recycling infrastructure and the share of cullage. However, it is not possible to substitute raw materials completely as cullage is of lower quality than newly produced glass, and there is glass loss which reduces the number of available shards. (FEVE 2026; GfE 2025)

Requirements to reach minimal residual emissions

The top three requirements to reach the level of minimal residual emissions are:

- Increasing the share of renewable and non-fossil fuels in raw material and cullage melting
- CCS infrastructure needs to be expanded sufficiently to capture process emissions.
- Increase technology readiness of technological options to substitute natural gas by hydrogen and renewable electricity

Scenario definition

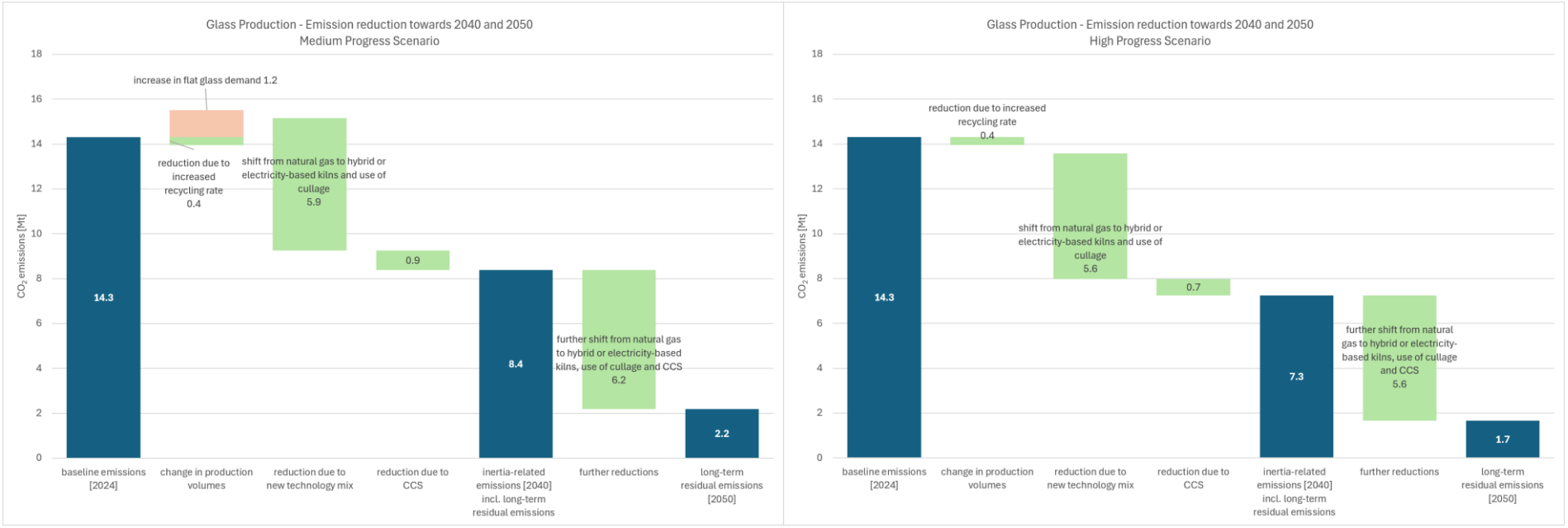
Two scenarios were defined for the glass sector. They differ in terms of production volumes that are expected in the respective sectors. The medium-progress scenario shows an increase of glass production in the future, due to the increase of flat glass demand caused by increasing building decarbonisation efforts (Glass for Europe 2020). The high-progress scenario on the other hand is characterised by a constant production volume. All other technological parameters are the same for the two scenarios:
For the sector it is assumed that natural gas is shifted out until 2050 and hybrid or electricity-based kilns are applied. Process emissions are addressed through CCS, leaving out all plants that show emissions of less than 100,000 tCO_2 per year and are therefore too small to be connected economically. The use of cullage is increased to an amount that is deemed technologically feasible without damaging electrodes in electricity-based melting. For container glass this is assumed to reach 70% in 2050, and 37% for flat glass.

Table 9 Glass - Scenarios

		Medium-progress scenario	High-progress scenario	Source
Production (primary and secondary) [Mt]	2024	39.5	39.5	
	2040	42.8	39.5	GfE (2025)
	2050	46.1	39.5	GfE (2025)
CO_2 emissions absolute [Mt CO_2]	2024	14.3	14.3	FEVE (2026)
	2040	8.4	7.3	FEVE (2026)
	2050	2.2	1.7	FEVE (2026)
CO_2 emissions specific [tCO2/t)	2024	0.36	0.36	
	2040	0.21	0.21	
	2050	0.05	0.04	

Source: Oeko-Institut

Quantitative results



The results show that a large share of emissions can be mitigated in both scenarios. The main difference is that the medium-progress scenario includes larger production volumes and therefore needs more renewable energy carriers and CCS capacities to reach climate neutrality. In both scenarios the CCS penetration is low, due to small installations in the glass sector. The high-progress scenario on the other hand can also mitigate emissions by remaining at constant production levels.

5.11 Ammonia

Sector overview

13.7 Mt CO_2 emissions in 2024	**3.1%** share of sector emissions in total EU-ETS1 Industry 2024	**18** installations in EU-ETS1	Average emissions per installation: **0.76 Mt CO_2/a** range: **0.1 – 3.1 Mt CO_2/a**	**65 %** process related emissions today

Source: 2024 data from EEA (2026a)

In Europe, ammonia is mainly produced on the basis of fossil natural gas by synthesis of nitrogen and hydrogen making use of the Haber-Bosch process (IEA 2021, figure 2.9). Hydrogen is produced by steam methane reforming (SMR) of fossil natural gas. Nitrogen is part of the synthesis gas (DECHEMA; Fertilizers Europe 2022).

About 70% of the ammonia production is used to produce fertilisers, the remaining share is used as a feedstock for the chemical industry (eg. plastics and synthetic fibres) (DECHEMA; Fertilizers Europe 2022, p. 27).

CO_2 emissions occur during the production of hydrogen, when fossil natural gas or another fossil hydrocarbon is used as the feedstock. The Haber-Bosch process does not cause CO_2 emissions. GHG emissions from ammonia production in Europe stem mainly from steam methane reforming of fossil natural gas. Steam methane reforming of gas results in two flue gas streams: one from the combustion of fossil gas to produce process heat, and one from the syngas stream after hydrogen has been captured.

Relevant indirect CO_2 emissions that are not EU-ETS1-relevant for this activity are emissions from electricity production (electricity is used for ancillary systems) and upstream emissions from fossil natural gas production.

Abatement options

Options to reach minimal emissions based on IEA (2021) are the following:

- Electrolysis of water to produce hydrogen (available technology)
- Biomass gasification or biomethane (however the potential of sustainable biomass is limited)
- Methane pyrolysis (lower TRL; remaining upstream methane emissions outside EU-ETS1)
- The uptake of alternative farming methods and alternatives to fossil fertilisers can reduce the demand for ammonia (Fraunhofer ISI; Oeko-Institut; IREES; Agora Agriculture 2024)

Other options include steam methane reforming of fossil natural gas with CCS. However, this pathway results in significant CO_2 emissions that will not be captured and remaining upstream methane emissions. Autothermal reforming of fossil natural gas

with CCS also results in CO_2 emissions that cannot be captured and remaining upstream methane emissions.

The **share of process-related CO_2 emissions** is currently very high, accounting for about 65% of total CO_2 emissions (DECHEMA; Fertilizers Europe 2022, p. 28). These are related to the fossil natural gas that acts as the feedstock in today's standard process. These process-related emissions do not occur anymore if hydrogen is produced from electrolysis of water.

When ammonia is produced based on renewable electrolytic hydrogen neither energy- nor process-related direct CO_2 emissions occur. Some remaining indirect CO_2 emissions might be related to ammonia production, if grid electricity is used for electrolysis and other surrounding technologies, and the grid are not fully decarbonised yet.

Carbon capture and storage is not necessary to reduce direct CO_2 emissions to a minimum, because there are no remaining process-related emissions when the hydrogen production is based on electrolysis of water.

Requirements to reach minimal residual emissions

The top requirements to reach the level of minimal residual emissions are:

- Large-scale availability of low-cost renewable hydrogen
  - Renewable energy uptake for renewable hydrogen production
  - Investment in large-scale electrolysis capacities
  - Investment in large-scale hydrogen transport infrastructure if relocation of current site is to be avoided
- Uptake of alternative farming methods and alternatives to fossil fertilisers

Scenario definition

For the medium-progress scenario, we assumed that demand for ammonia will remain constant. For the high-progress scenario, we assumed that production can be reduced due to alternative farming methods and alternatives to fossil fertilisers in accordance with Fraunhofer ISI; Oeko-Institut; IREES; Agora Agriculture (2024). This study documents the EU Target scenario with a 35% reduction of fertiliser use. This reduction is only applied to the 70% share of ammonia that is used for fertiliser production.

Global scenarios from the IEA (IEA 2021, figure 2.9), the World Economic Forum (Net-Zero Industry tracker 2023) and Mission Possible Partnership (Mission Possible Partnership 2022) (lowest-cost scenario) assume about 70% renewable-based ammonia and 30% fossil-based with CCS in 2050. However, these scenarios build on the global technology base, which today consists of ~25% coal-based and ~75% natural gas-based ammonia production. As in Europe the technology base does not include coal-based ammonia production the technology mix is assumed to shift from almost 100% SMR-based hydrogen production today to 100% hydrogen production based on

electrolysis in 2050. For 2040 we assume that 10% of the production is still based on SMR for the following reasons:

- We assume that hydrogen availability via the hydrogen backbone supplemented by local electrolysers will not reach all ammonia producers or cover all the demand by 2040.
- However, the capital stock of ammonia production plants (including the SMR plants) in Europe is relatively old, their age ranging between 30 and 50 years (IEA 2021, figure 1.10). Therefore, we assume that most of the plants are written off and (re-) investments could be streamlined into minimal emission technologies like the electrolysis of water.
- We do not assume that existing SMR would be retrofitted with carbon capture devices due to high remaining emissions of around 40%. This would leave the ammonia plants facing both high investment costs, costs for CCS energy demand and high EU-ETS1 costs for remaining emissions.
- New hydrogen production facilities based on autothermal reformers with CCS are assumed to be located rather at the coast close to CO_2 hubs for cost-efficient export of CO_2 and offshore storage. Hydrogen could be delivered as a service through the hydrogen backbone pipeline grid to the ammonia plants.

In 2050 there will be only renewable or other no-carbon technologies in place.

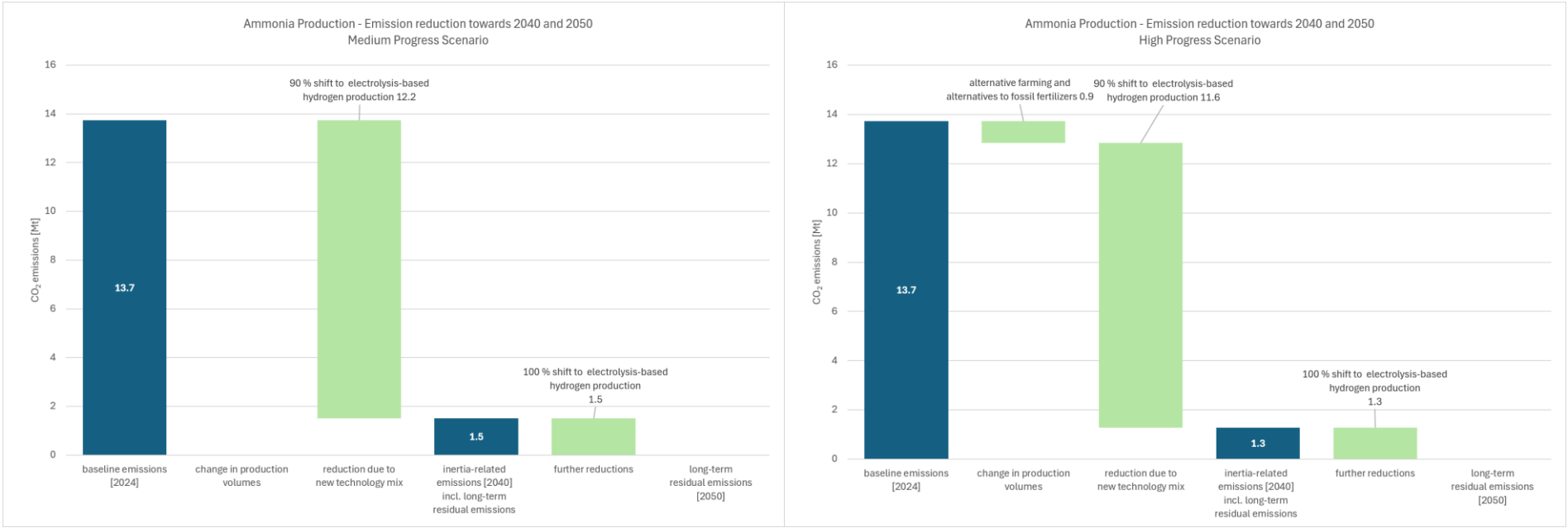
To calculate the remaining emissions for the technology mix, an emission intensity of 1.8 t CO_2 per tonne of ammonia is assumed (IEA 2021, p. 33).

Table 5-10: Ammonia production - Scenarios

[million tonnes]	Year	Medium-progress scenario	High-progress scenario	Source
Production [Mt]	2024	8.4	8.4	Data for year 2024 from Common Reporting Tables (CRT) of National Inventory Reports submitted in 2026 to UNFCCC
	2040	8.4	7.1	We assume linear degression from 2024 to 2050.
	2050	8.4	6.3	35% reduction as in EU Target scenario, related only to 70% fertiliser from ammonia, 30% remains constant
CO_2 emissions absolute [Mt]	2024	13.7	13.7	EEA (2026a)
	2040	1.5	1.3	Calculated with technology mix and emission intensity
	2050	-	-	

Source: Oeko-Institut

Quantitative results



The reduction in demand of ammonia due to alternatives to fossil fertilisers can reduce the emissions in the high-progress scenario. Due to the assumption that natural gas-based SMR plants can be replaced by hydrogen production based on electrolysis of water in both scenarios, the emissions from combustion of natural gas are assumed to be reduced substantially by 2040 and to reach zero in 2050.

5.12 Ceramics

Sector overview

9.2 Mt CO_2 emissions in 2024	**2.1%** share of sector emissions in total EU-ETS1 Industry 2024	**597** installations in EU-ETS1	Average emissions per installation: **0.02 Mt CO_2/a** range: **0.0 – 0.17 Mt CO_2/a**	**21%** process-related emissions today

Source: 2024 data from EEA (2026a)

The ceramics industry is a diverse sector with similar production processes, but diverse products. The largest sectors are wall and floor tiles, brick and roof tiles, and vitrified clay pipes. Although processes are similar the sector's heterogeneity is a challenge to its decarbonisation. The large number of small installations with different decarbonisation needs makes it impossible to apply a one-fits-all solution. The sector's fragmentation is especially challenging when it comes to CCS. Dispersed distribution and low emissions of single installations make it economically challenging to connect them to the CCS infrastructure (CerameUnie 2020).

The process of ceramics production consists roughly of four steps, which are shaping of ware, drying, firing and possible further treatments. The largest share of emissions are energy-related emissions with 79% that are emitted during drying and firing. A smaller share of 21% are process emissions that are emitted from raw materials while being fired in kilns (CerameUnie 2020).

Abatement options

The main options are the application of renewable fuels, electricity, efficiency gains and the application of CCS (CerameUnie 2020). This covers a large share of the sector, which is characterised of a 79/21 share of energy-related to process-related emissions. The ceramics sector struggles to mitigate process-related emissions as CCS cannot be applied to around 90% of the production sites, assuming a connection is feasible for installations with emissions of 100,000 tCO_2/a and above. Thereby, only 10% of production sites seem to be sufficiently large to be connected to the CCS infrastructure (see chapter 4.5 for detailed assumptions). It is unclear if decentralised CCS options can be developed to a TRL that allows decentralised plants to be connected to the infrastructure.

Requirements to reach minimal residual emissions

The following requirements need to be fulfilled for decarbonisation:

- Expansion of renewable energies and non-fossil fuels supply need to be secured to decarbonise energy-related emissions.
- TRL of electricity-based and hydrogen-based technologies need to be pushed through research and development towards practice. Respective infrastructure needs to be reinforced.

- The CCS technology readiness level needs to be increased and infrastructure needs to be expanded to mitigate process-related emissions.

Scenario definition

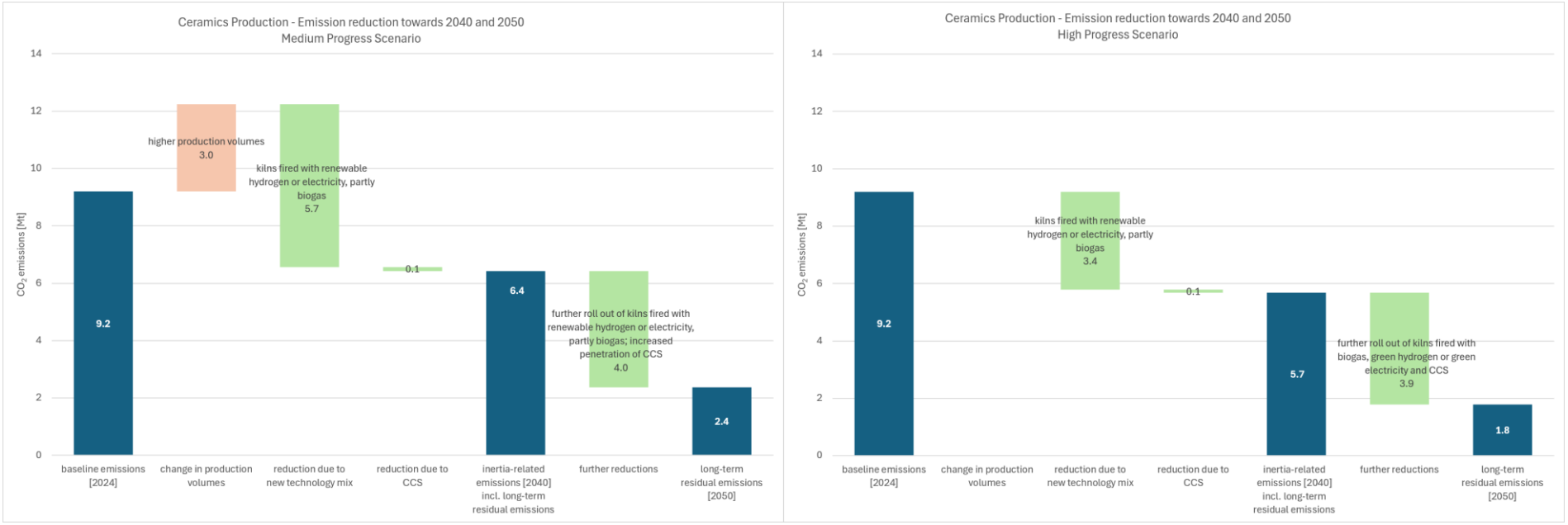
The medium-progress and high-progress scenarios are defined by the same technological configuration: An increase of connection of eligible plants to the CCS infrastructure and the roll-out of kilns fired with biogas, green hydrogen or green electricity. Ultimately the specific technological shares do not matter regarding the impact on energy-related emissions but rather need to be reviewed as regards potentials, availability and cost of energy carriers. The main difference of the scenarios can be found in the increase of production until 2050 in the medium-progress scenario.

Table 5-11: Ceramics - Scenarios

	year	Medium-progress scenario	High-progress scenario	Source
Production (primary and secondary) [Mt]	2024	37.0	37.0	
	2040	40.7	37.0	Joint Research Centre: Clean Energy Observatory (2024)
	2050	49.2	37.0	Ambegaonkar (2024)
CO_2 emissions absolute [Mt CO_2]	2024	9.2	9.2	
	2040	6.4	5.6	
	2050	2.4	1.8	
CO_2 emissions specific [tCO_2/t]	2024	0.25	0.25	
	2040	0.15	0.16	
	2050	0.05	0.05	

Source: Oeko-Institut

Quantitative results



The results show that a large share of emissions can be mitigated in both scenarios. The main difference is that the medium-progress scenario includes larger production volumes, and therefore needs more renewable energy carriers and CCS capacities to reach climate neutrality. In both scenarios the CCS penetration is low, due to small installations. The high-progress scenario on the other hand can also mitigate emissions only by remaining at constant production levels.

5.13 Hydrogen and synthesis gas

Sector overview

8 Mt CO_2 emissions in 2024	**1.8%** share of sector emissions in total EU-ETS1 Industry 2024	**62** installations in EU-ETS1	Average emissions per installation: **0.13 Mt CO_2/a** range: **0.0 – 1.2 Mt CO_2/a**	**65%** process-related emissions today

Source: 2024 data from EEA (2026a)

This main activity covers the production of hydrogen and synthesis gas produced by reforming or partial oxidation (EC 2024a). This hydrogen and synthesis gas production is the main activity of the plant and can be interpreted as "hydrogen-production as a service" for example in the case of a company producing hydrogen at a chemical park to supply hydrogen to different companies. Synthesis gas can be defined as industrially produced gases containing a mix of hydrogen and carbon-monoxide. Syngas is needed for various products today, such as methanol, fischer tropsch fuels, oxo chemicals, synthetic natural gas and acetic acid (Detz et al. 2024). Syngas is an intermediate product of future technology routes to produce renewable-based fuels and chemicals (such as methanol). However, some products such as methanol can also be produced directly using CO_2, without the reverse-water-gas-shift step to produce a syngas. Today, the production of hydrogen and syngas is mainly based on steam methane reforming of natural gas in Europe (authors' own research based on EU-ETS1 installation data). The EU-ETS1 installation data indicate that installations reporting under this activity code produce three main products: hydrogen, ammonia (only one installation), chlorine and carbon monoxide. Based on the installation data, hydrogen production (including hydrogen used for ammonia production) via steam methane reforming accounts for about 95% of emissions, while chlorine production is negligible. Synthesis gas production with a focus on the carbon monoxide accounts for about 5% of total emissions in this activity code. Therefore, the focus of this fact sheet is on hydrogen production.

ETS-relevant CO_2 emissions occur during the production of hydrogen or syngas, when natural gas or another fossil hydrocarbon is used as the feedstock. This process has two flue gas streams: one from the combustion of natural gas to produce process heat, and one from the syngas stream after hydrogen has been captured. Other indirect CO_2 emissions that are not EU-ETS1-relevant for this activity are emissions from electricity production (electricity is used for ancillary systems) and upstream emissions from natural gas production.

When hydrogen is produced based on electrolysis of water neither energy- nor process-related CO_2 emissions occur. For the specific production of synthesis gas, where the CO is needed, biomass-based solutions are available.

Abatement options

The main abatement options are replacing natural gas-based steam methane reforming with electrolysis of water to produce hydrogen. Biomass gasification or biomass

reforming are alternatives to produce hydrogen or syngas, however, limited potentials of sustainable biomass sources reduce the potential for these options (Detz et al. 2024).

Syngas can also be produced by electrolysis of water combined with CO_2 in a reverse-water-gas-shift reaction. However, this process has a low TRL of 6-7 (Detz et al. 2024).

Other options that do not lead to minimal residual emissions include steam methane reforming or autothermal reforming with carbon capture resulting in remaining CO_2 emissions due to a limited capture rate. Co-electrolysis of CO_2 and water is under development but remains at a low TRL of 5-6 (Detz et al. 2024).

Requirements to reach minimal residual emissions

The top three requirements to reach the level of minimal residual emissions are:

- Large-scale availability of low-cost renewable hydrogen
  - Renewable energy uptake for renewable hydrogen production
  - Investment in large-scale electrolysis capacities
  - Investment in large-scale hydrogen transport infrastructure if relocation of current site is to be avoided

Scenario definition

According to European Hydrogen Observatory (2025, p. 5), ~12% of the hydrogen and syngas production in 2024 takes place as a service outside installations of other EU-ETS1 activity codes. The larger share, i.e. ~ 88% of the overall 7.86 Mt of hydrogen and syngas production, takes place at installations of other activities. The demand for hydrogen in the medium-progress scenario is based on the S3 scenario, while the high-progress scenario is based on the S2 scenario of the European Comission's Impact Assessment (EC 2024b). We subtracted the hydrogen production that we assume to take place on site in installations of the activities: ammonia, chemicals, iron and steel and refineries.

To calculate the emissions of this activity we assume the following:

- 5% of today's emissions are attributed to syngas production, 95% to hydrogen production (based on our own analysis of EU-ETS1 installation data).
- We differentiate between today's hydrogen and syngas production and additional production that covers the strong uptake of hydrogen demand in other activities.
  - For **today's hydrogen and syngas demand** we assume that in 2040 5% of the production is production of syngas and remains to be produced from steam methane reforming of natural gas without CCS. The remaining 95% of hydrogen production is assumed to be produced mainly by electrolysis of water (75%) while the remaining share is still produced by steam methane reforming of natural gas without CCS. In 2050 the hydrogen demand from 2024 will be produced by electrolysis, while the syngas share is produced by new process routes based on biogas, biomass, co-electrolysis or electrolysis based on RWGS.

– For the strong **uptake of future hydrogen production**, we assume that in 2040 1.8 Mt of hydrogen will be produced by ATR plants including CCS, increasing to 3.5 Mt in 2050. This is in line with the IEA H2 database[20] which shows about 10 projects for hydrogen production based on fossil natural gas including CCS in Europe leading to a production volume of ~0,8 Mt. We assume a 10% share of hydrogen production via ATR CCS in 2050. The remaining production volumes of hydrogen are assumed to be produced via electrolysis of water.

- The CO_2 emissions are then calculated based on an emission intensity of 1.6 t CO_2 per tonne of hydrogen for the ATR route and 1.8 t CO_2 per tonne of hydrogen for the SMR route (IEA 2021). The capture rate of carbon capture is assumed to be 90%.

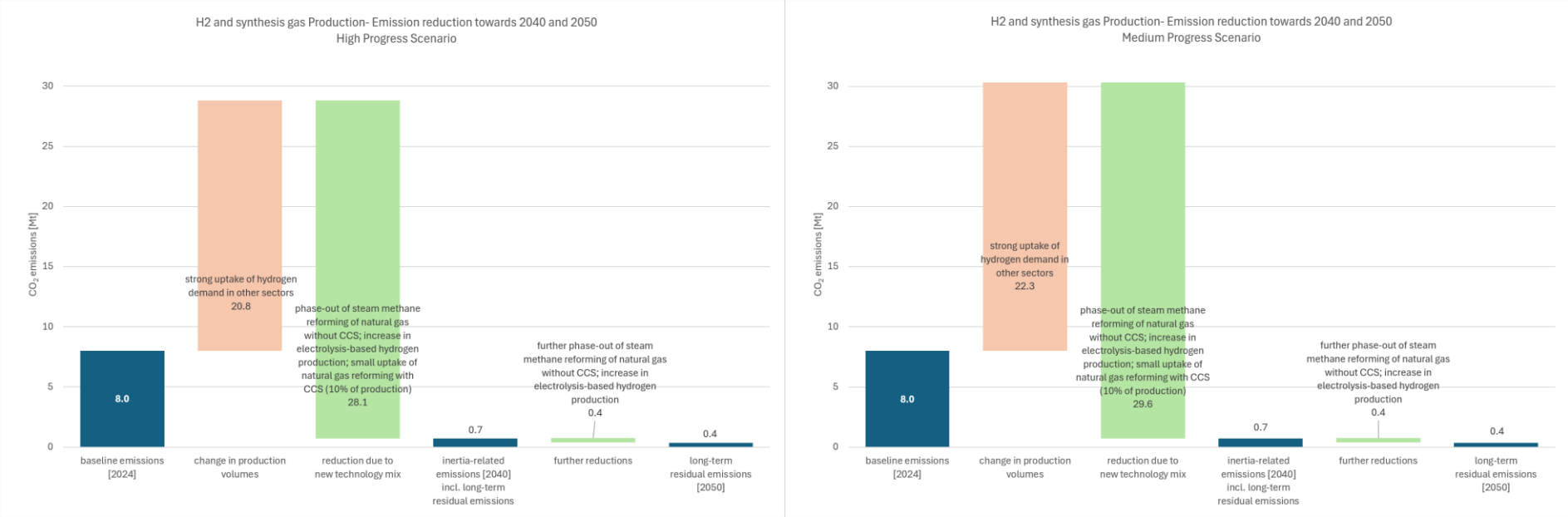
Table 5-12: Hydrogen and synthesis gas – Scenarios

	Year	Medium-progress scenario	High-progress scenario	Source
Production [Mt]	2024	0.9	0.9	European Hydrogen Observatory (2025, p. 5)
	2040	17.5	17.4	Authors' own calculation based on EC (2024b)
	2050	28.2	42.0	
CO_2 emissions absolute after CCS [Mt]	2024	8.0	8.0	Authors' own calculation
	2040	0.7	0.7	
	2050	0.35	0.35	

Source: Oeko-Institut

[20] https://www.iea.org/data-and-statistics/data-product/hydrogen-production-and-infrastructure-projects-database

Quantitative results



The quantitative scenarios show that the strong uptake of hydrogen production must be covered by electrolysis of water. This way the emissions from this activity can be reduced below today's emissions. Remaining emissions in 2040 as well as long-term residual emissions in 2050 do not reach zero but remain at low levels due to non-captured CO_2 emissions from the small share of hydrogen production based on the ATR CCS route.

5.14 Aluminium

Sector overview

7.3 Mt CO_2 emissions in 2024	**1.6%** share of sector emissions in total EU-ETS1 Industry 2024	**54** installations in EU-ETS1	Average emissions per installation: **0.13 Mt CO_2/a** range: **0.1 – 0.68 Mt CO_2/a**	**10%** process-related emissions today

Source: 2024 data from EEA (2026a)

The aluminium sector covers the production of alumina (Al2O3), the production of electrodes for primary aluminium smelting and the consumption of electrodes during electrolysis. For primary aluminium production three steps need to be taken: alumina refining (production of aluminium oxide from bauxite, Bayer Process); production of anodes and smelting of aluminium oxide. Refining of alumina takes place in only 7 plants in Europe with a capacity of about 4 Mt while 13 plants produce primary aluminium via electrolysis of aluminium oxide[21].

Secondary aluminium production uses scrap which is melted at about 700°C (European Aluminium 2023). The ovens that melt aluminium are mainly fired by fossil natural gas today. Downstream processes include extrusion and rolling and require thermal and mechanical energy (European Aluminium 2023). Thermal energy is mainly produced by burning natural gas today.

The production of aluminium oxide (alumina refining) is mainly based on fossil fuels (90%; FfE 2019a), direct emissions occur from burning fossil fuels to produce heat for the calcination in a kiln with temperatures of ~1,250°C. This step accounts for 15% of the GHG emissions in the European aluminium production (JRC 2026a). The production of anodes is also mainly based on fossil fuels (83%; FfE 2019a), direct emissions occur when burning the anodes at a temperature of ~1,200°C for about 48 hours. Per tonne of aluminium, about 0.3 tons of CO_2 stem from anode production. The production of aluminium in smelters is based on electricity (100%; FfE 2019a). Direct process CO_2 emissions occur due to the use of the anode material which reacts with oxygen in the process (about 1.6 tonnes of CO_2 per tonne of aluminium (IPCC 2006)).

Secondary aluminium and downstream process steps require high temperature heat, which is produced by burning natural gas resulting in CO_2 emissions.

Indirect CO_2 emissions are due to the intensive use of electricity (~14 MWh per tonne of aluminium) in the smelter step.

Abatement options

Options to reach minimal emissions in the process of primary aluminium production based on European Aluminium (2023) are the following:

[21] https://european-aluminium.eu/about-aluminium/aluminium-industry/#

- Digestion and calcination of alumina could be based on heat produced from electricity.
- Anode production could use electricity-based heat to burn the anodes.
- Electrical furnaces could be used in downstream segments.
- Increasing the share of secondary aluminium could reduce the emission-intensive primary aluminium production.

The process of secondary aluminium production could make use of electrified ovens or induction heating (European Aluminium 2023).

The **share of process-related CO_2 emissions** today is 10% (JRC 2026a). This is due to the use of anode material. Energy-related emissions can be reduced to zero as all fossil fuels can likely be replaced by electricity. However, it is crucial to develop inert anodes to higher TRL levels in the coming years to mitigate CO_2 emissions from anode use.

Carbon capture and storage would only play a role in intermediate transformation steps in case inert anodes are not available and the resulting emissions have to be captured.

The top requirements to reach the level of minimal residual emissions are:

- Technological development of necessary breakthrough technologies namely inert anodes and high-temperature electric thermal heat supply
- Uptake of renewable electricity to feed the new electrified heat technologies
- Increasing the share of secondary aluminium including closed-loop recycling systems

Scenario definition

Concerning the share of recycling aluminium, we start with a share of about 60% in 2024 (JRC 2026a). We assume for both scenarios that this share will increase to 70% in 2040 and 80% in 2050.

The share of production based on electrified process heat is close to zero today and is assumed to increase to 90% in 2040 and 100% in 2050 (based on European Aluminium (2023)).

The share of primary aluminium production making use of inert anodes is zero today and is assumed to increase to 50% in 2040 and 100% in 2050. However, there is quite an uncertainty if this technology is ready in time, especially by 2040 (based on European Aluminium (2023)).

For the production volumes we base our scenario on the assumptions of the S3 scenario of the EC Impact Assessment (EC 2024b) for the medium-progress scenario. For the high-progress scenario, we build on the LIFE scenario of the EC Impact Assessment (EC 2024b). Both scenarios assume an increase in aluminium production and use due to two reasons:

- The EC aims at reducing the share of aluminium imports that account for about 50% of aluminium use in the EU.
- The EC assumes that aluminium is a strategic material for future technologies like electric mobility, RES-E technologies and defence.

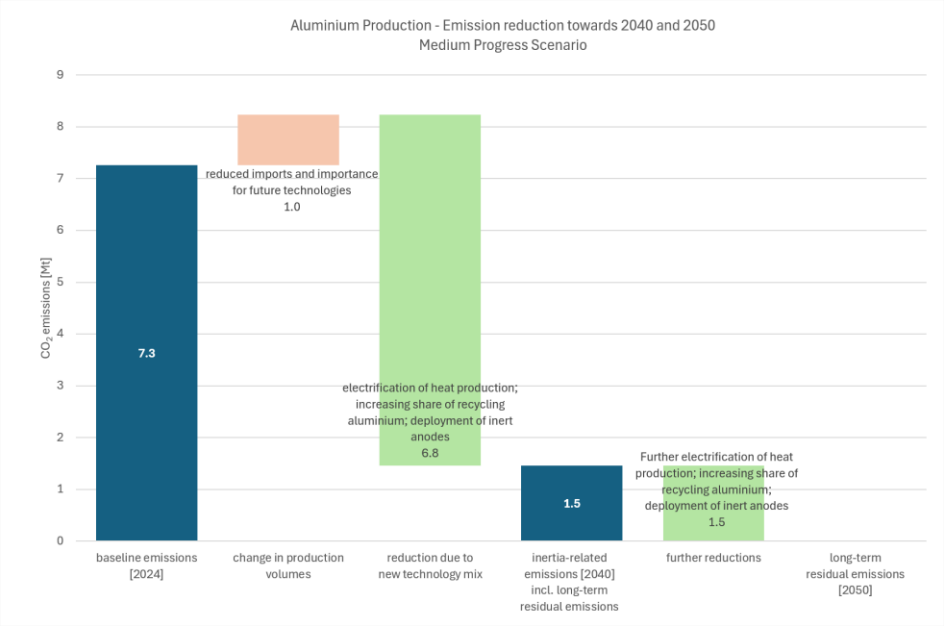
Table 5-13: Aluminium - Scenarios

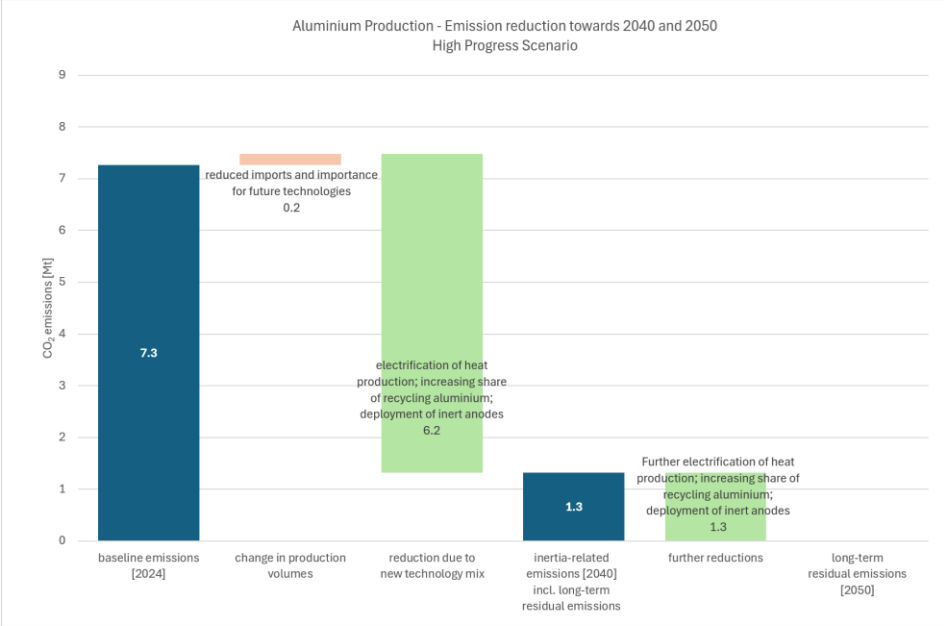
	Year	Medium-progress scenario	High-progress scenario	Source
Production (primary and secondary) [Mt]	2024	4.6	4.6	European Aluminium[22]
	2040	5.2	4.7	Authors' own calculations
	2050	6.2	4.9	Authors' own calculations
CO_2 emissions absolute [Mt]	2024	7.3	7.3	Authors' own calculations based onEU-ETS1 data
	2040	1.5	1.3	Authors' own calculations
	2050	-	-	Authors' own calculations

Source: Oeko-Institut

[22] https://european-aluminium.eu/about-aluminium/aluminium-industry/

Quantitative results





Both scenarios show an increase in production. However, emissions from aluminium making can be reduced substantially by electrifying process heat and increasing the share of recycling aluminium. Zero long-term residual emission can be reached if emissions from the use of anode material can be abated. This needs alternative anodes to reach the necessary technological readiness levels in time.

5.15 Other sectors

Sector overview



17 Mt CO_2
emissions in 2024



3.9%
share of sector emissions in total EU-ETS1 Industry 2024



392
installations in EU-ETS1



Average emissions per installation:
0.04 Mt CO_2/a
range:
0.0 - 1.5 Mt CO_2/a



About 65%
process-related emissions today

Source: 2024 data from EEA (2026a)

The previous sections analysed those activities where most EU-ETS1 emissions are currently generated. This section clusters all remaining industrial activities. These activities covered less than 4% of industrial EU-ETS1 emissions in 2024 and less than 1% of total EU-ETS1 emissions. The analysis was performed on a coarser level and its main purpose is to provide some gap-filling to present total numbers for the whole EU-ETS1. EU-ETS1 activities included in this sector are production of non-ferrous metals[23], mineral wool, gypsum or plasterboard, carbon black, nitric acid, adipic acid, soda ash and soda bicarbonate as well as activities opted in under Art. 24 of the EU-ETS1 directive.

Abatement options

As the activities included in the 'Others' aggregate could not be analysed in detail based on sector specific literature the only two abatement options considered are based on well-founded assumptions:

- Replacement of fossil fuels with other energy carriers, thus 100% of energy-related emissions can be avoided. For high-temperature process firings alternatives to fossil fuels are limited but with hydrogen-based furnaces at least a backstop technology is available.
- CCS is a viable option at large installations (>100 kt CO_2/a). However, CCS is not perfect as it can only capture 90% of CO_2 (where applied).

Scenario definition

As the main purpose of the quantification is to provide gap-filling to calculate the total EU-ETS1 figures no differentiation was made between the two scenarios.

Both replacement of fossil fuels and deployment of CCS are assumed to reach half scale by 2040 and full scale by 2050.

Table 5-14: Other sectors - Scenarios

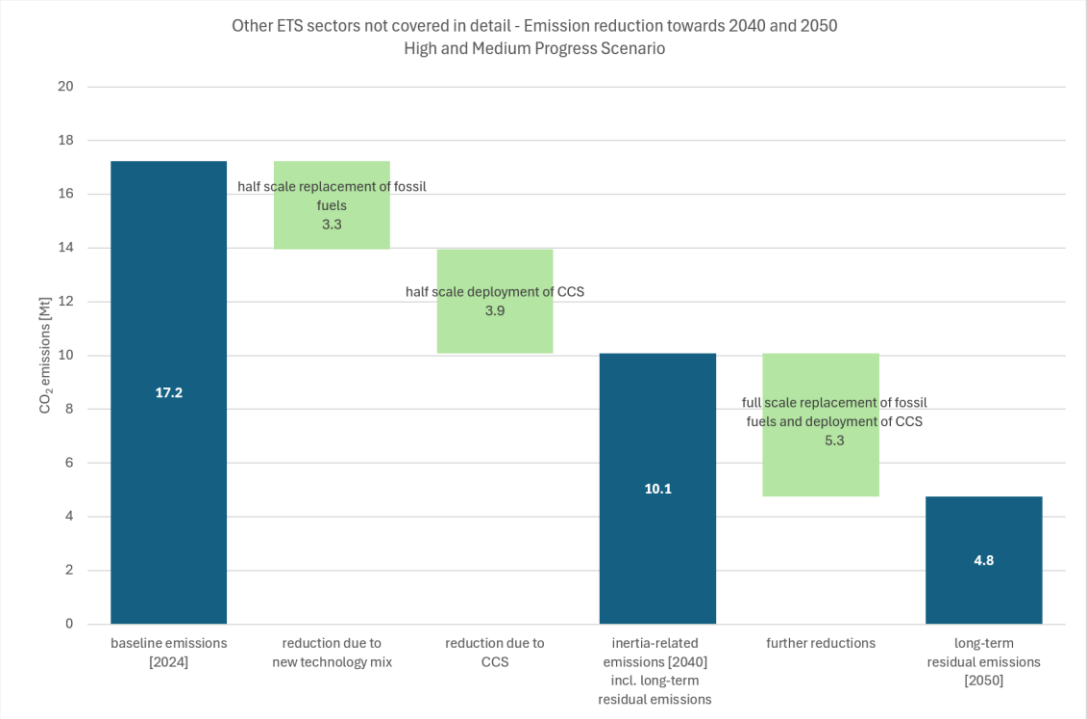
	Year	Technology	Medium- and high-progress scenario
Technology	2024	share large installations (≥ 100 kt/a) without CCS	62%
		share large installations (≥ 100 kt/a) with CCS	0%

[23] Except aluminium

	Year	Technology	Medium- and high-progress scenario
		share small installations (<100 kt/a) without CCS	38%
		Reduction fossil fuels	0%
	2040	share large installations (≥ 100 kt/a) without CCS	31%
		share large installations (≥ 100 kt/a) with CCS	31%
		share small installations (<100 kt/a) without CCS	38%
		Reduction fossil fuels	-50%
	2050	share large installations (≥ 100 kt/a) without CCS	0%
		share large installations (≥ 100 kt/a) with CCS	62%
		share small installations (<100 kt/a) without CCS	38%
		Reduction fossil fuels	-100%
CO_2 emissions absolute [Mt]	2024		18.0
	2040		3.2
	2050		0.0

Source: Oeko-Institut

Quantitative results



The result of the analysis shows that emissions of these activities can be reduced by about three quarters. With the use of CCS for process emissions and the replacement of fossil fuels by sustainable energy carriers, emissions from these activities can be reduced to 7.8 Mt CO_2 in 2040 and 4.8 Mt CO_2.

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oeko.de | info@oeko.de

Contact

Christoph Heinemann | Öko-Institut Consult gGmbH | c.heinemann@oeko.de

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