

Mapping the transition of the EU cement industry to carbon neutrality

2026

HIGHLIGHTS

- ▶ Most decarbonisation trajectories for the EU cement industry anticipate emission reductions of 20-40% by 2030 and full decarbonisation by 2050.
- ▶ Carbon capture, utilisation and storage (CCUS) technologies are expected to play the largest role in abating sectorial emissions in the long-term (capturing in average 50% of sectoral emissions in the analysed trajectories), followed by the use of alternative materials and emerging fuels.
- ▶ The demonstrators mapped in this factsheet align with the main decarbonisation trajectories, with 40 of the 60 cement-related projects focusing on CCUS technologies.
- ▶ Although most of the cement-producing groups in the EU have committed to reducing emissions by 2030 (27% reduction on average), only 22% of the cement plants are hosting demonstration projects. These belong to 10 of the 20 major producing groups.
- ▶ For the sector to be aligned with its pledges and targets, the roll-out of demonstrated technologies needs to occur fast and at scale, and the deployment of CO₂ capture (which offers the largest abatement potential) needs to be widespread.

THE CHALLENGE

Introduction

Cement is a powdery substance made from limestone, clay and other minerals. The main application of cement is to give structural stability to concrete, which is the most widely used construction material across the globe. However, the production of cement is responsible for the vast majority (>90%) of concrete's associated greenhouse gas (GHG) emissions. The approximately 170 million tonnes per annum (Mtpa) of cement currently being produced in the EU lead to around 110 Mtpa of CO₂ emissions [1] (more than 3% of the EU's total GHG emissions).

The production of cement contributes roughly EUR 7.6 billion to the Union's Value Added and is linked to

around 40 000 direct jobs [1]. Although the EU has consistently been a net exporter of cement in recent decades, export and import flows only make up around 10% of the amount produced [2]. This is partly due to the fact that cement transportation costs are high compared to its value, and cement plants are generally sized to satisfy local demand.

EU cement production was significantly affected by the 2008 financial crisis, but has stabilised in recent years. Some projections indicate that by 2050, demand will increase by up to 15% of current values [1], [3], reflecting a recovery in the building sector as well as ongoing urbanisation and the construction of new infrastructure.

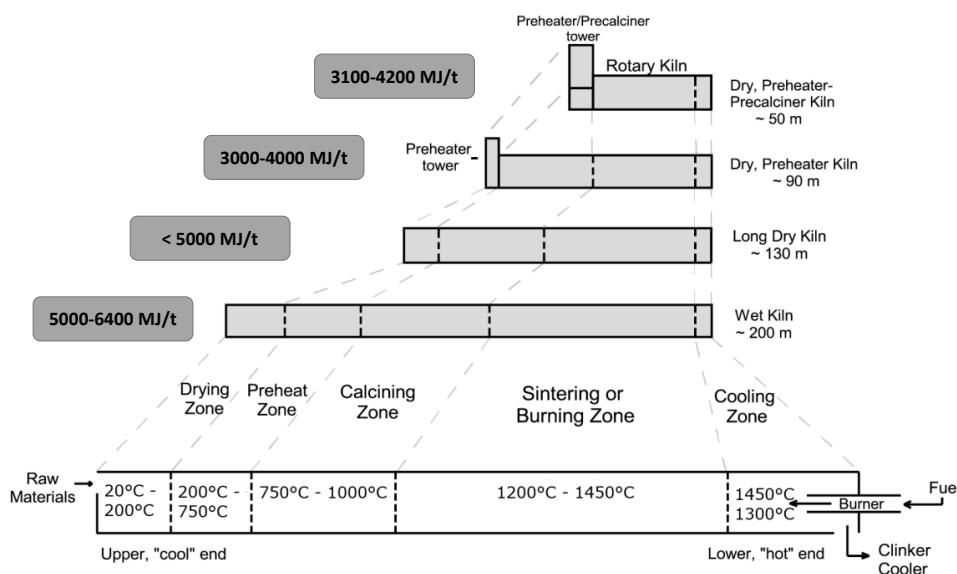
Decarbonising the production of cement is therefore crucial for the EU's industrial competitiveness. In this factsheet, one of a series examining the status of the

main industrial sectors across the EU, we analyse the challenges, the way forward and the state of development of the sector's transition towards climate neutrality.

Production process

Cement is the result of grinding clinker with gypsum, supplementary cementitious materials and other additives. The proportion of clinker varies according to the type of cement (from 5% to 99% by weight [2])

Figure 1 - Types of clinker production facilities, including approximate length, functional zones and indicative process temperatures as well as thermal energy requirements per tonne of clinker.



Source : JRC adapted from [2]

in terms of process complexity and energy intensity and is typically produced in rotary kiln reactors (and to a lesser extent in vertical shaft kilns). Cement production plants that combine the production of clinker with the grinding of cement constituents are called integrated plants. They represent the majority of operating plants in the EU (around 200 out of 250 installations). Among these, over 150 are (at least partially) owned by a group which holds three or more plants; the largest are HeidelbergMaterials (with 41 plants), Holcim (29), Buzzi Unicem and CRH (16 each), and Cemex (10) [2].

The vast majority of cement production in the EU is based on Portland clinker, although this has been decreasing in recent years. Portland clinker is formed from calcium silicates and calcium aluminates. Drying and pre-heating the raw materials are the most energy-intensive steps. Various kiln technologies are currently in use, based on the type and humidity of the raw materials treated. Figure 1 shows an overview of the different technologies, their functional zones and process temperatures, and the specific thermal demand of each. Wetter raw

materials lead to higher thermal energy demands. However, the percentage of the dry process used in EU cement production has evolved to more than 90%, and wet process facilities are on their way to being phased out [3].

Current CO₂ emissions

The CO₂ intensity of cement-making varies, depending on the technology used, the clinker-to-cement ratio and the fuel mix used within the country where the production is located. Nonetheless, the vast majority of the CO₂ emissions in cement (and concrete) production stem from the production of clinker. In fact, while the average clinker content of EU cement is 74% [1], the CO₂ emissions associated with its production are 94% of total emissions (representing 95% of the cement-related emissions in concrete). Thus, it is clear that the clinker content of cement is a crucial factor in the final cement's emission intensity, and its reduction is a key decarbonisation lever.

Table 1 summarises the CO₂ emissions from clinker production and their categorisation according to the GHG Protocol. Emissions belonging to Scope 3 are typically neglected in contrast to Scopes 1 and 2 (and are thus disregarded in this factsheet), but we recognise that transitioning towards decarbonised cement production will certainly influence the broader life cycle emissions of the construction sector.

Table 1 – Overview of the CO₂ emissions of clinker and cement production, including the different scopes, sources and intensities.

Scope	Source	Relevance (intensity)
1	From chemical process (calcination)	526 kgCO ₂ /t clinker
	From on-site thermal energy production	0-685* kgCO ₂ /t clinker, being the EU average 282 kgCO ₂ /t clinker
2	From electricity consumption (mainly grinding)	30 kgCO ₂ /t cement
3	From raw material sourcing and other intermediate products	Negligible

*The extreme values correspond to either the use of sustainable biomass for heating (carbon neutral) or the wet process using oil shale for heating.
Source: JRC adapted from [2]

Policy targets and context

The EU has set clear ambitions for achieving climate neutrality by 2050 as enshrined in the European Climate Law, with a short-term target to reduce GHG emissions by at least 55% as compared to 1990 levels by 2030. This target, set in 2021 and defined in the European Green Deal and the Fit-for-55 legislative package, led to the creation of the Industrial Technology Roadmap for Low Carbon Technologies in Energy Intensive Industries, with a direct impact on R&D initiatives in the cement sector. More recently, the European Commission has recommended a [2040 climate target](#) of reducing net emissions by 90% compared to 1990 levels. As part of this proposal, industry is required to reduce its emission levels by 60-90% compared to 1990.

Other relevant policy mechanisms and initiatives with direct influence on the decarbonisation of cement production are the EU Emissions Trading System, the Net-Zero Industry Act, the voluntary low-carbon cement label under the Clean Industrial Deal and the Industrial Carbon Management Strategy. In addition, the [Innovation Fund](#) is currently funding 16 projects in the cement and lime industry, with a total EU funding of EUR 2.4 billion. Lastly, certain policies are increasingly creating markets for low-carbon cement and concrete, such as the Energy Performance of Buildings Directive, the forthcoming Industrial

Accelerator Act and the revised Construction Products Declaration.

THE WAY FORWARD

Decarbonisation trajectories¹

A decarbonisation trajectory is here defined as a projected evolution of the CO₂ emissions reduction that the sector will undergo from the current situation (with 2021 as reference) until 2050. Trajectories are typically the result of simulation studies that model the sectorial deployment of the various decarbonisation technologies available (see Section *Decarbonisation technologies*).

This section presents an overview of the main decarbonisation trajectories identified for the EU cement industry, briefly introduced in Table 2, where the total emissions abatement (as a percentage of current emissions) in 2030, 2040 and 2050 are displayed. Most of the trajectories (except “Inertial”, which represents a linear emission reduction without major changes) lead to (close to) 100% emissions reduction by 2050. Nonetheless, large variations are observed in terms of the trajectory: while “POTEnCIA” projects a delayed implementation of decarbonisation technologies (9% achieved by 2030, which is even less than the “Inertial”, due to the relatively slow uptake of CCUS, projected in POTEnCIA to be deployed at scale after 2030), the remaining trajectories predict an average decarbonisation of 20-45% by 2030.

Figure 2 breaks down the trajectories by the decarbonisation technologies upon which they rely (grouped according to the classification depicted in detail in Section *Decarbonisation technologies*) by 2050. CCUS technologies dominate across all trajectories (contributing between 29% and 80% of the respective decarbonisation objective), with the exception of “New processes” and “Circular economy”. A recent review [4] provides more detail on the role of CCUS technologies. *Alternative materials* is the second largest decarbonisation lever across

¹ This factsheet avoids using the term ‘pathways’ to prevent confusion with the sector-specific decarbonisation pathways published by the European Commission in November 2025. Those sector-specific pathways are intended as a voluntary tool to support companies set their individual

decarbonisation targets in line with the European Climate Law. See [EC, Making finance flows consistent with climate goals – Climate Action, 2025](#)

Table 2 – Overview of the decarbonisation trajectories of the cement sector mapped in the literature.

Authorship (Ref year) [Ref]	Trajectory Name	Total emission abatement*			Cost
		2030	2040	2050	
Material Economics (2015) [7]	New processes	36%	59%	100%	EUR 6.8 billion per year (+34% of current investments)
	Circular economy	45%	68%	100%	EUR 6.3 billion per year (+22% of current investments)
	Carbon capture	27%	68%	100%	EUR 8.6 billion per year (+49% of current investments)
The European House Ambrossetti (2022) [8]	Inertial	20%	40%	50%	-
	Zero carbon	45%	85%	100%	-
Cembureau (2021) [9]	Roadmap 2050	45%	94%	100%	-
EC-JRC (2021) [10]	POTEnCIA	9%	87%	93%	117 EUR/t

Source: JRC, 2026

trajectories, abating an average 25% of sectorial emissions by 2050, followed by *alternative fuels* (which includes electrification) and *energy efficiency* with 14% and 2% respectively.

New decarbonised production trajectories entail significant added costs for cement production. Electricity becomes a major part of production costs for any electrified route, and the increased capital costs of transport and storage of CO₂ become significant factors. The cost of the different trajectories is outlined in Table 2. Material Economics report that investment requirements for their net-zero transitions increase by 22-49% as compared to 2020 levels, the highest increase being associated with the “Carbon Capture” scenario. In “POTEnCIA”, the trajectory leads to a total production cost of 117

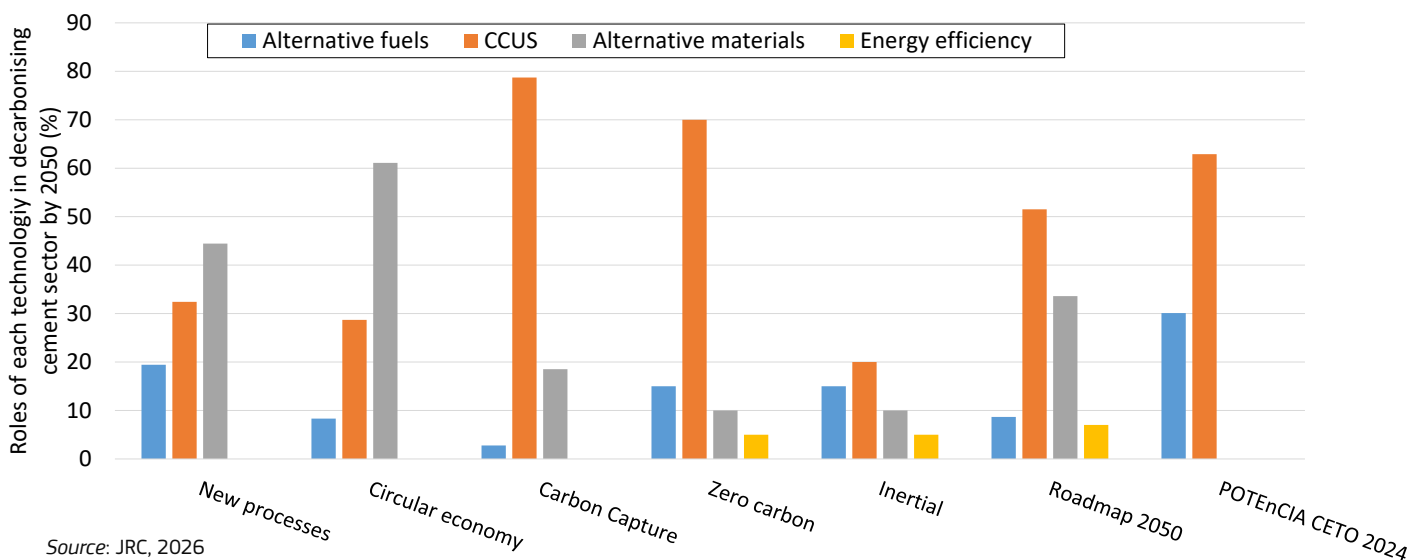
EUR/t by 2050 (including a small fraction due to the non-abated CO₂ emissions), which is more than double the current levels.

When looking at global projections, the International Energy Agency expects a 26% decrease of CO₂ emissions by 2030, down to 96% by 2050, attributing to CCUS technologies more than 50% of the abatement [5]. In turn, the Global Cement and Concrete Association projects net-zero production by 2050 (with CCUS abating 36% of the emissions) and a 20% reduction (from 2020 levels) by 2030 [6].

Figure 2 - Overview of the main decarbonisation trajectories mapped in this work and the roles of each decarbonisation theme by 2050.

*CCUS in Zero carbon scenario include Carbon dioxide removal technologies

**Alternative fuels in New processes, Circular economy and Carbon capture scenarios include energy efficiency measures.



Source: JRC, 2026

Figure 3 - Overview of the main decarbonisation technologies sorted by themes and categories, their abatement potential, cost and TRL.

Themes	Categories	Abatement potential	Cost	Maturity
Alternative fuels	Alternative fossil fuels Biomass fuels Mixed wastes Emerging fuels (electricity / hydrogen)	10-50%	0-30 EUR/tCO ₂	High
			30-50 EUR/t	Low
CCUS	CO ₂ capture CO ₂ transport CO ₂ utilisation CO ₂ storage	50-90%	60-170 EUR/tCO ₂	Medium
Alternative materials	Alternatives to calcium carbonate Alternative binder chemistries Alternative materials to Portland clinker/cement Additives	10-50%	40-70 EUR/tCO ₂	High
Energy efficiency	Waste heat use Electrical efficiency Cooling efficiency Overall process improvements	5-10%	0.5-10 EUR/tCO ₂	High

Source: JRC based on [2], [13] and [14]

Decarbonisation technologies

There are many decarbonisation technologies in the cement sector; these technologies vary in terms of cost, abatement potential, and development level. Discrepancies in the taxonomy are common across publications, which hinders a homogeneous analysis. The classification and taxonomy recently published by the JRC [11] is used as the basis for the present work.

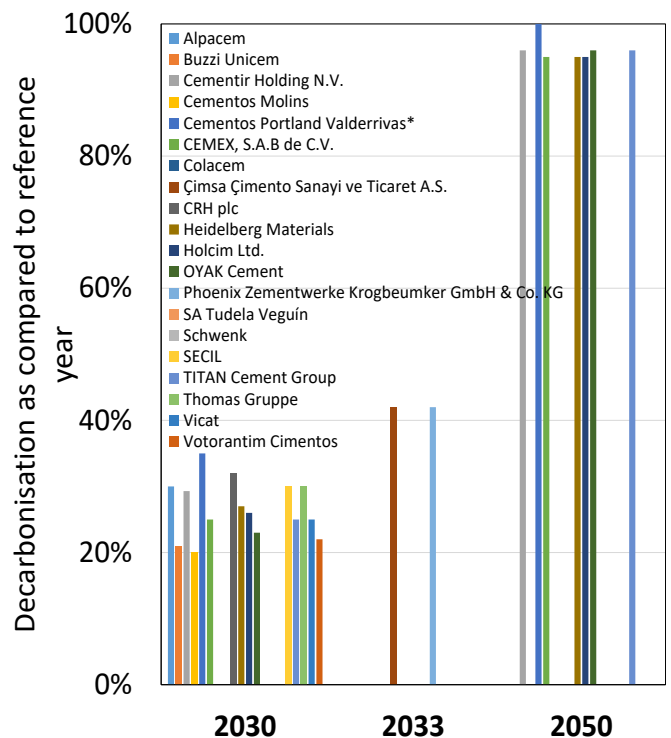
Figure 3 depicts an overview of the taxonomy, cost, maturity level and abatement potential of the decarbonisation technologies included in the trajectories shown in Table 2. Figure 3 reveals that CCUS is the theme with largest abatement potential (50-90%) as it can address both process and fuel emissions, followed by *Alternative materials* (10-50%) and *Alternative fuels* such as electrification (up to 50%). Nonetheless, CCUS technologies applied to the cement sector are generally at a lower maturity (typically measured as TRL) than some of the other solutions, although this very much depends on the capture technology deployed (in fact the first [commercial CCS plant](#) applied to the cement sector recently began operating in Norway). It is very important to highlight that costs are directly linked to the development level of each technology, and thus the costs of those technologies at lower TRLs are expected to decrease over time (see [12] for the effect of this on CCUS costs).

STATE OF DEVELOPMENT

Industrial pledges

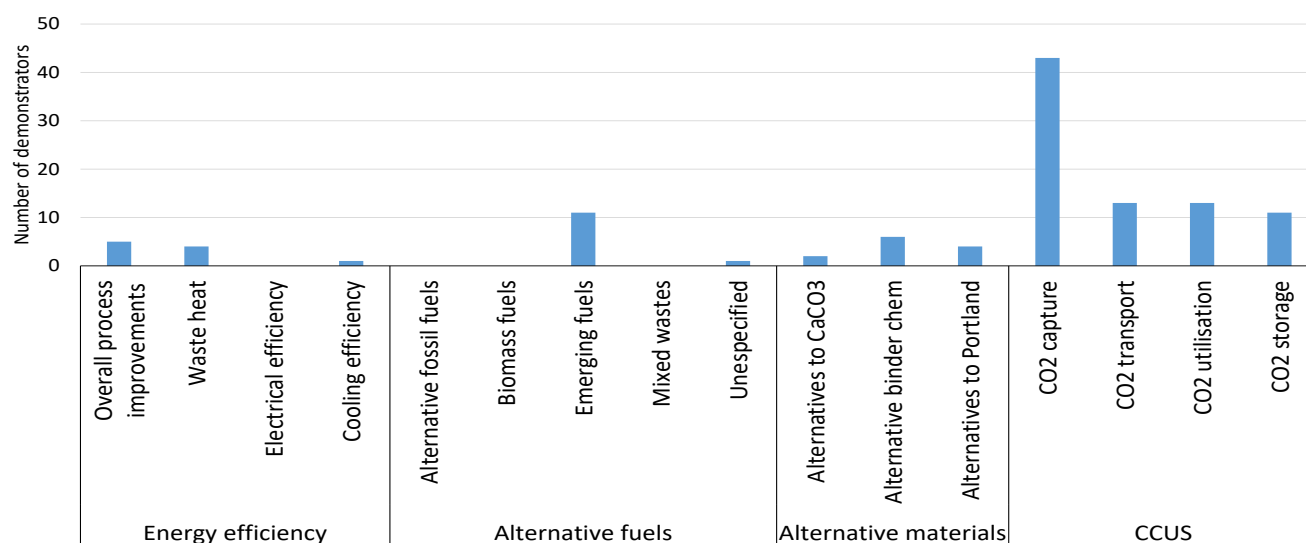
Figure 4 displays the decarbonisation targets of most of the major cement production groups. Note that the values included in Figure 4 are mainly Scope 1 and 2, although a few are only Scope 1 and some

Figure 4 - Decarbonisation targets (as % of a reference year) of the major EU industrial groups of the cement sector. * Indicate groups that belong to larger holdings and so are their targets.



Source: JRC based on [SBTi](#)

Figure 5 - Cement-related EU demonstrators included in this work sorted by the categorisation presented in Figure 3.



Source: JRC, 2026

companies also set targets for Scope 3 (not included here). It can be observed that there are more groups reporting targets for 2030 than for 2050 (only 7 groups report for both) and that the groups intend to decarbonise their production, on average, by 27% by 2030. All groups with a 2050 target aim to decarbonise more than 95% as compared to the reference year, with only one group (Cementos Portland Valderrivas) targeting 100%. Note that most groups use 2020/21 emission levels as the reference year for their target, with very few (Buzzi Unicem, Holcim and Colacem) using pre-pandemic levels (2018 and 2019).

Demonstrators

The demonstration projects mapped in this work² represent cutting-edge initiatives aimed at accelerating industrial decarbonisation through innovative technologies and sustainable practices. Only projects that received EU funding and that involve technologies at demonstration level are included in the analysis, resulting in 60 projects related to the cement production sector, spanning all stages of development – from initial concept studies to facilities under construction and operating.

Figure 5 displays an overview of the decarbonisation projects mapped. The demonstrator projects in the cement sector are mostly focused on CCUS technologies, particularly on the capture step of the CO₂ chain (and to a lesser extent covering the full

CCUS chain). Emerging fuels represent the second most frequent category. These observations are in line with the status of development and abatement potential depicted in Figure 3, where CCUS and emerging fuels are characterised by low-medium TRLs and high potential. In fact, some of the decarbonisation levers (such as electrical and cooling efficiency improvements) are already available at commercial scale and are therefore not included in the demonstration categorisation.

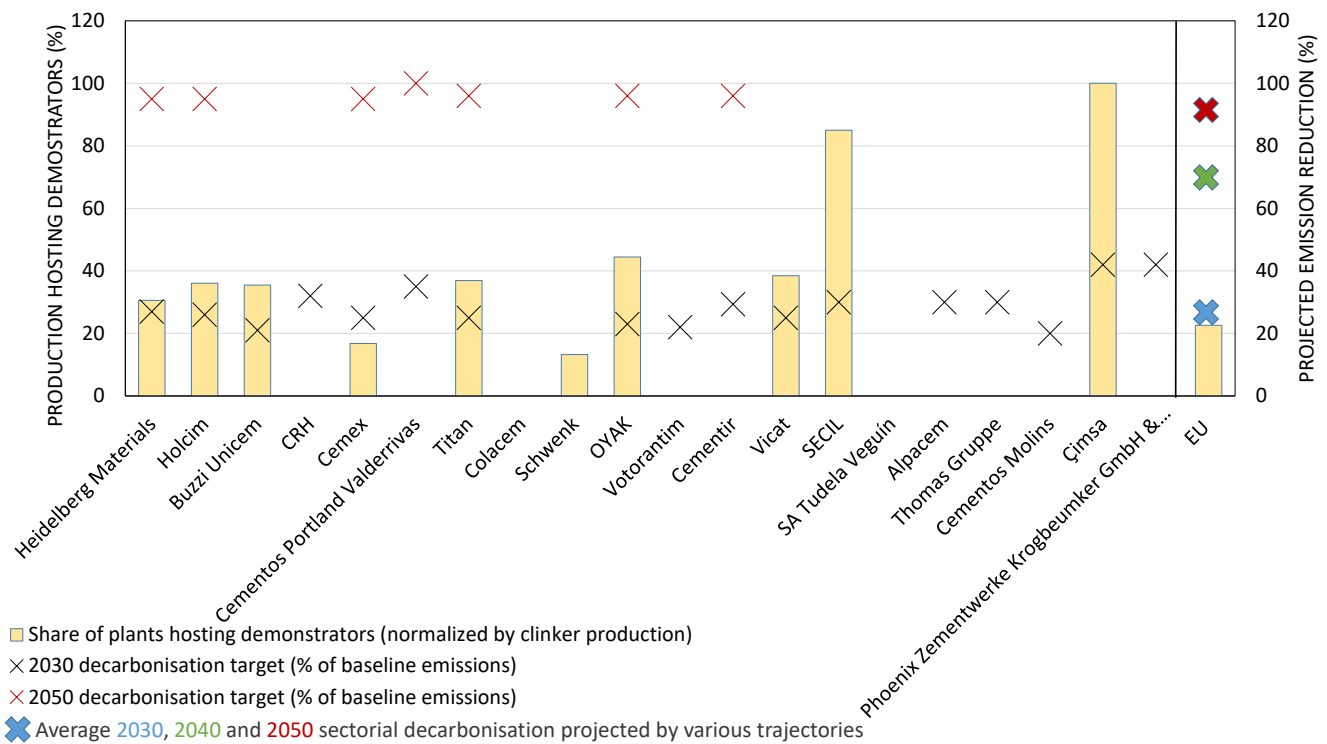
In terms of geographic spread the cement demonstrators mapped are predominantly located in Germany, (12 plants), followed by Greece and France (6 each), and Spain and Belgium (5 each). For reference, note that the top five production countries within the EU are, in descending order, Spain, Italy, Germany, France and Poland.

Evaluation of progress and alignment with policy and industry targets

In this section we evaluate the alignment of the sector's decarbonisation with the industrial pledges and trajectories presented above, using the demonstrators mapped in this work as a proxy. Figure 6 depicts the share of plants of the major groups that host a demonstration project, normalised by the

² Mapping of demonstration plants in energy intensive industries (INCITE) layer on [EIGL website](https://energy-industry-geolab.jrc.ec.europa.eu/) (https://energy-industry-geolab.jrc.ec.europa.eu/)

Figure 6 - Percentage of cement production hosting a decarbonisation demonstration project for the main EU cement production groups, and for the EU as a whole. For reference, the 2030 and 2050 decarbonisation targets of each group have been added (right axis), as well as the average projections for the EU in 2030, 2040 and 2050 according to the mapped trajectories.



Source: JRC, 2026

clinker production of each plant (i.e., a demonstrator placed in a large plant counts as more than one in a smaller plant). Note that the average value across groups is 22%, with some groups (Çimsa, which owns only one plant and Secil) hosting demonstrators in 100% and 80% of their production sites. For the sake of comparison, the 2030 and 2050 decarbonisation targets detailed in Figure 4 were added to Figure 6. Results of the analysis indicate that i) if the demonstrators are scaled up to industrial scale and achieve deep emissions cuts, 50% of EU cement producers would be on track to meet their short-term targets, and ii) two cement producers with ambitious targets for 2050 have no demonstrators in place yet. It is important to note that many decarbonisation technologies presented in Figure 3 are commercially available and are thus not mapped within demonstration projects.

The combined clinker production of all cement plants hosting a decarbonisation demonstrator results in a share amounting to 22% of EU production (also included in Figure 6). For comparison, the trajectories presented in Section *Decarbonisation trajectories* project a decarbonisation of EU cement production within the range 9-46% in 2030, averaging 27% (also added to Figure 6), which indicates that the EU demonstrators are relatively well aligned with the trajectories in the short term. Nonetheless, the achievement of the

targets relies on scalable decarbonisation technologies and replicability across sites. For reference, note that the analysed trajectories average a decarbonisation of 71% of current levels by 2040 and of 92% by 2050. Thus, decarbonised capacity would need to more than triple within the next 15 years to be aligned with the trajectories.

CONCLUSIONS

The decarbonisation of the cement sector presents both significant challenges and opportunities. While there is a wide variety of technological options available, these involve -increases in investments amounting to approximately 20-50% compared with current levels, which would lead to a doubling of cement production costs. The mapped demonstration projects are a good example of how to streamline funding towards achieving climate targets. Of the 60 cement-related demonstrators mapped, more than 40 are focused on the capture, transport, utilisation and/or storage of CO₂. This interest in driving the development of CCUS technologies is justified by its potential to abate 50-90% of the sector's emissions, and its leading role in most of the trajectories analysed. The rest of demonstrators mapped focus mainly on the use of alternative materials and emerging fuels, which have the opportunity to

decrease emissions in the shorter term despite their limited abatement potential. These demonstrators are located in 22% of the EU's cement production plants, belonging to 10 of the 20 major groups producing cement in the EU. Industry and governments must ensure the scalability and replicability of demonstrated technologies to allow these groups to remain aligned with their decarbonisation targets.

References

- [1] Eurostat, *Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E) (2005-2020)*, 2024, https://ec.europa.eu/eurostat/databrowser/view/SBS_NA_IND_R2/default/table?lang=en
- [2] Marmier, A., *Decarbonisation options for the cement industry*, Publications Office of the European Union, Luxembourg, 2023, Report No.: JRC131246, <https://data.europa.eu/doi/10.2760/174037>
- [3] Joint Research Centre: Institute for Prospective Technological Studies, *BAT Reference document for the production of cement, lime and magnesium oxide*, Publications Office of the European Union, Luxembourg, 2013, Report No.: JRC83006, <https://data.europa.eu/doi/10.2788/12850>
- [4] Martinez Castilla G., *The role of carbon capture across hard-to-abate industries in the EU: a review of projections for 2030 and 2050*, Joint Research Centre, European Commission, 2024, Report No.: JRC139742, <https://publications.jrc.ec.europa.eu/repository/handle/JRC139742>
- [5] IEA, *Cement* [Internet], Paris, IEA, 2023, <https://www.iea.org/reports/cement-3>
- [6] Global Cement and Concrete Association, *Cement Industry Net Zero Progress Report*, <https://gccassociation.org/cement-industry-net-zero-progress/>
- [7] Material Economics, *Industrial Transformation 2050 - Pathways to Net-Zero Emissions from EU Heavy Industry*, 2019, <https://materialeconomics.com/publications/industrial-transformation-2050>
- [8] The European House Ambrosetti, *Zero Carbon Technology Roadmap*, 2022, <https://www.eni.com/content/dam/enicom/documents/eng/visione>

</accessible-energy/Zero-Carbon-Technology-Roadmap-Complete-2022-eng.pdf>

- [9] Cembureau, *From ambition to deployment - The road travelled, pathways and levers to scale up our net zero ambition*, 2024, <https://www.cementeuropa.eu/media/g44cyp5a/cembureau-net-zero-roadmap.pdf>
- [10] European Commission, Joint Research Centre, Neuwahl, F., Wegener, M., Salvucci, R., Jaxa-Rozen, M., Gea Bermudez, J. et al., *POTEnCIA CETO 2024 scenario: energy system modelling for clean energy technology scenarios*, Publications Office of the European Union, Luxembourg, 2024, <https://data.europa.eu/doi/10.2760/1473321>
- [11] Marmier, A., *Learning from publicly funded research on cement decarbonisation options*, Joint Research Centre, European Commission, 2024, Report No.: JRC 137848, <https://publications.jrc.ec.europa.eu/repository/handle/JRC137848>
- [12] Beiron J, Johnsson F., *Progressing from First-of-a-kind to Nth-of-a-kind: applying learning rates to carbon capture deployment in Sweden*, *International Journal of Greenhouse Gas Control*. 2024;137(May), <https://doi.org/10.1016/j.ijggc.2024.104226>
- [13] European Commission, Joint Research Centre, Martinez Castilla, G., Tumara, D., Mountraki, A., Letout, S., Jaxa-Rozen, M., et al. *Clean Energy Technology Observatory Status Report on Carbon Capture Utilisation and Storage*, Publications Office of the European Union, Luxembourg, 2024, Report No.: JRC139285, <https://data.europa.eu/doi/10.2760/0287566>
- [14] Glenk, G. et al. *Cost-Efficient Pathways to Decarbonizing Portland Cement Production*, MIT, 2023, Report No.: CEEPR WP 2023-12, <https://ceepr.mit.edu/workingpaper/cost-efficient-pathways-to-decarbonizing-portland-cement-production/>

Disclaimer

The opinions expressed are those of the author(s) only and should not be considered as representative of the Commission's official position

Copyright

© European Union, 2026



Science for policy

Scan the QR code to visit:

[The Joint Research Centre: EU Science Hub](https://joint-research-centre.ec.europa.eu)
<https://joint-research-centre.ec.europa.eu>

CONTACT INFORMATION

European Commission, Joint Research Centre (JRC)
E-mail: Guillermo.Martinez-Castilla@ec.europa.eu
Jose.Moya@ec.europa.eu, RTD-E3-ASSIST@ec.europa.eu