GLOBAL CCS INSTITUTE

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Cement with CCS

Frequently Asked Questions

Overview of Carbon Capture and Storage (CCS) in the Cement Sector

Why do we need CCS for the cement sector?

Cement production is one of the largest industrial sources of CO_2 emissions, accounting 7–8% of global CO_2 emissions, and it is growing. Today, CCS is the only scalable solution for near-zero emissions in cement production. Here is a fact sheet that explains CCS's role in the cement sector: CCS 101.

Can we reduce all cement emissions by switching to renewable energy?

No. The common cements used worldwide are based on carbonate minerals, primarily limestone (calcium carbonate). When heated, these raw materials release CO_2. This CO_2 is referred to as "process emissions" because it is from the raw materials, not the heating fuels. About 60% of the total direct emissions from cement production are from these process emissions. Consequently, even when the heating source changes to a renewable source, CCS is critical in addressing process emissions.

Why should we invest in and develop CCS now?

CCS enables certain industry sectors, such as cement, to provide low-carbon products. While there are lower-cost mitigation options in this sector, such as increasing the use of supplementary cementitious materials (SCMs), switching to alternative fuels, and reducing emissions before capture, none of these options offers the deep CO_2 reductions needed to align with net-zero goals, making it essential to begin deploying CCS. Cement plants are long-lived industrial assets and CCS projects have long lead times. The groundwork must start now to ensure the technology can be deployed to meet our climate goals.

Will CCS stifle innovation in emerging decarbonisation technologies and approaches?

No. A wide range of innovative and possibly transformational technologies are currently being developed and tested to decarbonise the cement sector including new chemistries, new processes and new ways of heating the process, for example electrolysis, electrification and biobased solutions. The key issue for many of these innovations is scalability. CCS can scale low-carbon cement production without compromising cement quality or performance and can be deployed now, reducing the buildup of CO_2 emissions in the atmosphere, while these new technologies develop.

Is CCS only an option for new cement plants?

No. CCS can be integrated into new plants and added to existing plants as a retrofit, which is where most near-term deployment is expected. Cement plants have long lifetimes, and many that are operating today will still be operating in 2050.

Integrating CCS Into Cement Production

How is CO_2 captured at a cement plant?

In a cement plant, most CO_2 is generated when limestone is heated in a large kiln to make clinker, the main ingredient in cement. CO_2 generated during clinker production can be captured using chemical solvents, solid materials, membranes, cryogenic systems, or hybrid combinations to separate it, enabling transport, storage, or reuse rather than release into the atmosphere. This factsheet shows how CCS fits into the cement and concrete value chain: CCS 101.

Can CCS capture all of the emissions from cement plants?

CCS can capture 90–95% of CO_2 emissions from cement plants, including both process- and combustion-related emissions, depending on the technology and integration approach. Common integration approaches include:

- Post-combustion capture using solvents, membranes, or cryogenic capture.
- Oxy-fuel combustion, which burns fuel in pure oxygen to produce a CO_2-rich flue gas.
- Calcium looping, leveraging the cement process chemistry for CO_2 capture.
- Other approaches, such as indirect calcination.

How does CCS integration affect cement plant operations?

Cement kiln flue gas has 18–25% CO_2 concentration, significantly higher than coal-fired power plants (~12–15%). This higher concentration makes CCS more energy-efficient for cement compared to some other sectors. However, adding capture units can increase cement plant size by 100% and more than double cement production energy demand. Operating capture units can also require additional raw materials and worker skill sets that are new to the cement industry.

When designing plants, important considerations include optimising plant efficiency and maximising the use of low or zero-carbon energy. For example, renewable energy can be used for electrical loads and waste heat from the kiln can help supply solvent regeneration energy.

Will CCS impact cement quality or performance?

No. CCS integration will not compromise the safety or performance of cement. Regardless of whether a cement plant uses CCS technology, cement products must comply with rigorous quality and performance standards, established by national regulatory bodies and independent certification bodies, such as ASTM International, the European Committee for Standardization, International Organization for Standardization. Cement producers must routinely verify product performance through rigorous testing and quality assurance processes, including for strength, durability, setting time, chemical composition, and consistency.

Where can captured CO_2 from cement plants be stored?

CO_2 can be permanently stored in deep saline formations or depleted oil and gas reservoirs. Between 1996 and 2024, nearly 400 million tonnes of captured CO_2 have been stored underground in geologic formations. For more information, go to: The London Register of Subsurface CO_2 Storage. At a smaller scale, CO_2 can also be used in the chemical and synthetic fuels industries and permanently stored through mineralisation as CO_2 reacts with alkaline materials (e.g. recycled aggregates or mineral carbonation).

Is CO_2 storage safe?

Yes. CO_2 storage is widely considered safe when it is done in properly selected, well-characterised, and carefully regulated geological formations. As of early 2026, there were 27 commercial dedicated CO_2 storage projects. There were also 36 enhanced oil recovery or EOR projects that monitor CO_2 injection and storage and over 50 pilot and demonstration projects. These projects capture CO_2 from various industrial sources and are designed with robust requirements for site selection, operation, and monitoring. Here is more information on the Safety and Permanence of Geological Storage: CO_2 Geological Storage Perspective

Scaling CCS in the Cement Sector

Are there any real-world CCS projects in the cement sector?

Yes. This factsheet lists several projects operating globally: CCS101 factsheet. There are also projects focused on new ways to capture CO_2. For example, the Low Emissions Intensity Lime and Cement (LEILAC) project separates CO_2 directly at the point of creation when limestone is heated. It uses a special reactor that keeps the CO_2 from calcination separate from the combustion gases, producing a concentrated CO_2 stream that is simpler and potentially cheaper to capture. Several industrial-scale cement CCS projects have been announced to come into operation by 2030, supported by the EU Innovation fund, which can pave the way to deployment: Green Cement Technology Tracker - Leadership Group for Industry Transition.

What is the timeline for CCS in cement to scale?

Scaling CCS in the cement industry is largely dependent on a combination of strong policy interventions for CCS and receptive market conditions. Demonstration projects are the current focus and this will continue towards 2030. With the right conditions, commercial deployment can expand from 2030 with the prospect of widespread adoption in the 2040's to align with the Global Cement and Concrete Association's Roadmap for Net Zero Concrete, which envisages that CCS will contribute around 36% of the sector's overall decarbonisation.

What are the challenges of implementing CCS in cement plants?

Key challenges for CCS include:

- High upfront capital costs, operating costs, and uncertain revenue streams.
- Space and energy requirements for capture and compression.
- Need for infrastructure for CO_2 transport and storage.
- Regulatory and permitting timeframes.

These challenges are surmountable with policy and regulation, a clear market value proposition, and integrated engineering activity, as demonstrated by existing CCS in cement facilities.

What is the economic cost of cement with CCS?

The Mission Possible Partnership estimates that the cost increase for net-zero cement is around 40–120%, mainly driven by CCUS investment. At the building level, this translates to a 1.5–3% increase for residential construction, so the cost to the consumer is relatively modest. At the plant level, costs are highly variable, depending on a number of physical, geographical and legislative factors. Policy can reduce costs through support measures and direct subsidies. For example:

- Shared CO_2 transport and storage networks.
- Public-private partnerships for demonstration projects.
- Long-term Carbon Contracts for Difference (CCfDs) to guarantee revenue for low-carbon cement.

What co-benefits does CCS bring beyond emissions reduction?

Investing in the domestic manufacturing base helps secure local jobs, industrial competitiveness, and the security of critical supply chains. By enabling the production of low-carbon cement, CCS helps meet growing demand for sustainable construction materials, supporting broader climate and infrastructure goals. It can support economic growth and competitiveness, particularly in regions with strong cement and construction sectors, by enabling low-carbon production without relocating industry. In addition, CCS drives innovation and the development of new infrastructure, including shared CO_2 transport and storage systems that can benefit multiple industries and create new jobs. CCS can also contribute to environmental improvements beyond climate change, such as better air quality, since capture systems require pre-removal of pollutants like sulfur dioxide, nitrogen oxides, and particulates.

How does CCS fit into national climate targets and industrial decarbonistion strategies?

Without CCS, cement emissions would remain a major obstacle to achieving national and international targets. Including CCS in industrial policy roadmaps would help ensure alignment with long-term climate commitments.

What policy instruments can accelerate CCS deployment?

A range of policy instruments can help accelerate the deployment of CCS. Symmetric carbon pricing mechanisms, such as taxes or cap-and-trade systems, can make CCS more economically viable by increasing the cost of emitting CO_2. Financial incentives, such as the U.S. 45Q tax credit, reward companies for capturing and storing emissions, while direct government funding through grants and subsidies can support early, first-of-a-kind projects. Governments can also stimulate demand by procuring low-carbon cement for public infrastructure projects. In parallel, investment in CO_2 transport and storage infrastructure is essential, along with clear legal frameworks for permitting and long-term stewardship. Finally, including CCS within broader industrial decarbonisation roadmaps helps provide long-term direction and policy certainty for the sector.

What are some essential steps to develop a CCS project for cement?

Deploying CCS requires balancing technical, logistical, and commercial considerations, including efforts to:

- Characterise the plant's technical profile (emission intensity, flue gas characteristics, available space, and existing abatement measures) to guide technology selection.
- Assess and secure access to CO_2 transport, storage, or utilisation infrastructure, and structuring offtake agreements.
- Evaluate the applicable policies, securing funding mechanisms, and gaining certification for green premiums to support project bankability.
- Advance the project engineering from initial pre-feasibility assessments to Front-End Engineering Design (FEED).
- Obtain appropriate permits and licenses.
- Engage with communities on the project and associated infrastructure.