CEMEX is actively engaged in exploring all Carbon Capture and Storage (CCS) technologies as applied to the cement production process.

## How does Carbon Capture and Storage Work?

There are two key concepts involved in CCS: separation of carbon dioxide ($CO_2$) from other gases, and its storage or confinement. CCS is a way of taking the $CO_2$ produced from energy-intensive processes, separating it from the rest of the exhaust gases, and transporting and storing it underground so that it cannot enter the atmosphere. CCS has the potential to capture a significant proportion of the $CO_2$ produced in a cement kiln from both the combustion of fossil fuels and the calcination of limestone.[1] There are several basic approaches to the separation of $CO_2$, but only two of them—post-combustion and oxy-fuel combustion—have been identified as potentially feasible in the cement industry.

**Separation:** Post-combustion technology means the separation of the $CO_2$ from the exhaust gas after, or at the end of, the cement kiln; it would apply to existing cement plants without significant modifications to the production process. Oxy-fuel combustion technology means operating the cement kiln with a mixture of pure oxygen and recycled $CO_2$, instead of the normal ambient air, resulting in a pure $CO_2$ exhaust gas. This may be a long-term solution, and will be more applicable to new cement plants, since a new generation of burners, cement kiln lines, and plant configurations will be required.

**Storage:** $CO_2$ can be stored in a number of ways: in depleted gas and oil fields, in deep saline aquifer formations, in coal seams that can no longer be mined, or injected into declining oil fields to increase the amount of oil recovered (more commonly known as Enhanced Oil Recovery, EOR). These structures have stored natural gas, crude oil, brine, and $CO_2$ over millions of years.

[1] Calcination is an important component of the cement-making process in which raw materials are heated to temperatures above 1,000 degrees Celsius. Reaching these extreme temperatures takes a very large amount of energy, making alternatives to fossil fuels a crucial part of CEMEX's strategy to reduce its environmental footprint.

## The Challenges of Carbon Capture and Storage

CEMEX believes that the cement industry should continue to explore how CCS could be integrated into cement production. The International Energy Agency (IEA) has developed a Technology Roadmap for the Cement Industry and unveils CCS as an important lever to achieve significant reductions of $CO_2$ emissions. However, the technology is not yet commercially available.

CEMEX and the cement industry are committed to do their share to overcome the numerous technical challenges and to bring the cost of CCS down to a reasonable level. However, government support and co-funding will be required at all of the key stages—lab-scale, pilot plant, and demonstrator—to manage the significant costs and risks in this process. At the moment, CEMEX notes with some concern that public CCS funding seems to be geared toward the power sector, neglecting the potential long-term cost advantages that the application of this technology in other sectors, such as the cement industry, promises.

Public support might also be required for the development of pipelines and storage sites. Otherwise, the widespread application of CCS will face a typical chicken-and-egg problem: without infrastructure, operators will not invest in $CO_2$ capture, and without sources of concentrated $CO_2$ there is no incentive to develop a pipeline and storage network.

At the same time, governments will have to provide the necessary regulatory framework for CCS. This means a stable, long-term carbon market with reasonably predictable price levels, and the development of CCS-specific legislation that pragmatically defines the ownership of porous space in subsurface structures and the responsibility for the risk of $CO_2$ leaks. Private industry is not in a position to assume such risks on its own.

CEMEX is also aware that, apart from the above-mentioned technical, economic, and regulatory factors, there is also the question of social acceptance.

## CEMEX Carbon Capture and Storage Actions

Since 2002, CEMEX has been studying CCS in collaboration with other companies, international organizations, and academic institutions. CEMEX is also participating in a major European project at the European Cement Research Academy (ECRA), with the goal of examining the technical and economical feasibility of CCS in the cement industry.

In late 2009, CEMEX was awarded funding by the U.S. Department of Energy's National Energy Technology Laboratory (NETL) to conduct groundwork for the development and demonstration of a commercial-scale CCS project at CEMEX's Odessa, Texas, cement plant. This study, executed together with other industrial partners, concluded that commercial-scale CCS in the cement industry is not yet ready for deployment. Significant research and small-scale experimentation is needed before full-scale implementation. With a grant from CEMEX, the Imperial College in the UK is carrying out additional fundamental research on CCS.

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## Looking Forward

CEMEX sees CCS as a potential mid-term solution to limit carbon emissions, and will continue to pursue all funding opportunities for the advancement of this technology. Nevertheless, even under the most optimistic scenario, we do not expect to conduct a first industrial-scale project at one of our plants in the near term. To a large extent, whether CCS can live up to its promise will depend on governments and society as a whole. Public funding for well-designed research and development projects, the necessary political developments, and open and transparent discussion with our stakeholders about the pros and cons of CCS will be required.