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Capturing cement's carbon: piloting LEILAC technology in Belgium and Germany

Project: Low Emissions Intensity Lime And Cement (LEILAC)

Sector(s): climate change, industry

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8%

of global CO_2 emissions are related to cement and lime production, and are unavoidable

Summary

The Paris Agreement provided the clear objective of keeping a global temperature rise of below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to below 1.5°C. This has been supported by widespread government and industrial commitments for carbon neutrality by 2050.

This is not an easy commitment to reach for the cement industry: one of the most widely used substances on the planet. Despite being extremely efficient processes, the industry is responsible for 8% of global CO_2 emissions. This is because most CO_2 emissions are 'process emissions', released directly and unavoidably from limestone when it is heated.

Capturing this CO_2, and ensuring that it does not reach the atmosphere, is the only means of stopping these emissions - as noted by the IPCC in its reports – but to date it has been expensive to implement.

Supported by the European Union, the LEILAC (Low Emissions Intensity Lime And Cement) projects are developing a breakthrough technology that aims to enable the cement and lime industries to capture those unavoidable CO_2 emissions emitted from the processing of raw limestone.

About LEILAC

The Calix process changes the existing process flows of a traditional calciner by indirectly heating the limestone via a special steel reactor. This unique system enables pure CO_2 to be separated and captured as it is released from the limestone, by keeping the furnace exhaust gases separate. LEILAC operates, in principle, with the same specific energy as conventional cement and lime plant. Unlike other capture technologies, the new process does not involve any additional processes or chemicals, and simply involves a novel "calciner" (kiln) design. It is therefore a very low-cost way of capturing unavoidable CO_2 process emissions.

The first pilot project, which commenced in 2016, sought to apply this technology to the cement sector. The successor project, which started in 2020, is applying this at a larger scale to an operational cement plant, capturing 20% of its emissions, or 100ktpa of CO_2, at low cost. The aim, if successful, is for this technology to be applied at full scale globally in the coming years to contribution to decarbonisation efforts.

Results

- The LEILAC1 project constructed a Pilot plant at the HeidelbergCement plant in Lixhe, Belgium to investigate whether Calix's novel process for efficient, low-cost CO_2 capture could be applied to the cement and lime sector.
- Extensive research, development and engineering was necessary to design and construct the pilot. To apply this technology quickly and effectively, the European-Australian collaboration LEILAC projects include consortiums of some of the world's largest cement, and lime companies, as well as leading research and environmental institutions. The research and development programs were agile and responded to the needs of the project as they arose. Local government played a key role in supporting the project and overseeing its permitting. Combined with the guidance, contribution, and experiences of the industry experts, this has enabled the feat of constructing a first-of-a-kind pilot on time and on budget in 2019. With the commencement of operations, initial trials of the LEILAC pilot are extremely promising and the technology is working as expected.
- In 2021 a roadmap will be released, including life cycle analysis and view on the ability to use electricity, hydrogen and low carbon fuels.
- While still to be pushed to its full capacity, the pilot is designed to separate CO_2 at a rate of around 18,000 tonnes per year, the equivalent to the annual emissions of around 10,000 cars.

Concrete is the 2nd most consumed substance in the world, after drinking water

Next steps

- Work has started on a scale up project called LEILAC2, again supported by the European Union's H2020 scheme. This involves constructing a plant with four times the capacity of the current Pilot, with a plant being constructed in Germany. Both integrating and scaling up the technology to the cement industry carries a number of risks – but addresses the major remaining hurdles before roll-out, and will be capable of capturing 20% of the plant's capacity, or around 100,000 tonnes per year, the equivalent to the annual emissions of around 55,000 cars[1].
- The Demonstration plant aims to be fuel agnostic, aiming to use the host site's fuels, and biofuels.

[1] Based on the average EU car emitting 1.8 t CO_2 per year from 720 litres of fuel. "CO_2 Emissions from Cars: The Facts", 2018 European Federation for Transport and Environment

"CCS plays a major role in decarbonizing the industry sector in the context of 1.5°C and 2°C pathways, especially in industries with higher process emissions, such as cement."

2018 IPCC report

- The Pilot will also be electrified and can already use hydrogen. There is the possibility to use these calciners for load balancing – allowing more renewable energy generation on the grid.
- The LEILAC2 Demonstration plant is a module that can be easily duplicated, paving the way for swift, cost effective deployment of this carbon capture technology across the globe.

Enabling conditions

The LEILAC projects were realised due to the support and commitment of the European Union, and the resulting research programmes for high risk, very large projects to protect industry. Without support for such high-risk projects, which are expensive as they need to be applied at an industrial scale, such technologies would struggle to be developed.

Permitting of the pilot plant, and associated regional governmental support and flexibility, were vital in enabling the build to progress smoothly and quickly. Such understanding, and encouragement, really enabled the first-of-its-kind decarbonisation plant to be progressed.

Development of a wide partner base – covering industry, public institutions, academia, engineering, and consulting groups - also provides significant benefits to critical industrial development. The support of the local government has been invaluable, with mayor and MEP representation at the pilot's ground-breaking event sending clear and strong message of support.

Local and national governmental support is invaluable to enabling such projects and will be increasingly important as they are deployed at full scale. Doing so will require infrastructure, particularly for the transportation and storage of CO_2, that are often beyond the ability of single companies – and are more cost-efficient if done for multiple users. Norway has seen this as an opportunity, supporting the Longship project which has ambitions to store CO_2 for the entire region. Similar initiatives may be needed on a regional basis to ensure that local industry can be retained and operate in a safe, profitable, and sustainable manner.

Ultimately clear policy commitments – as demonstrated with the Paris Agreement and the development of supporting instruments and regulations – are critical for the development of level playing fields, enabling the provision of economic low-carbon products to society.

Challenges

- Technical issues are significant with such large-scale, first of a kind, novel technologies. There is nothing easy or simple about decarbonising industry which involves unavoidable CO_2 process-related emissions - but these can be overcome.
- Dedicated projects which are supported by industry and public policy (with or without funding) are critical. These are ultimately for public and social good, combating climate change and providing customers with safe, low carbon, affordable products – but to ensure a unified and clear vision for that objective, all stakeholders need to be working together.
- Financial support is important for high-risk innovation projects. With LEILAC, we expect that the costs associated with capturing cement and lime emissions are dramatically reduced. However, transport and storage infrastructure for CO_2 needs to be put in place to deal with the captured CO_2. To enable CCS as a clean technology, government leadership and support (regulatory, permitting, and perhaps even state ownership of key infrastructure) may be needed – to ensure that this critical aspect of the dealing with the CO_2 is made in a timely, safe manner without driving unacceptably high costs onto the consumer.

"By providing a low-cost means of capturing hard-to-abate process CO2 emissions, the LEILAC process has the potential to allow the cement and lime industries to continue to safely operate into a carbon-constrained future with an effective, efficient, safe and environmentally friendly solution."

- Regulatory frameworks for CCS are largely in place (for example all member states have transposed the EU CCS Directive).
- Public resistance to storage, particularly onshore storage, has also played a role in some cases, notably in Europe. This has been due to it being seen as a "fossil fuel technology" for coal-fired power stations. However, for the lime and cement industries it is the only effective route to decarbonise – and with LEILAC it can enable the use of renewable electricity.

Key lessons learned

- Stronger climate targets and investment incentives are injecting new momentum into carbon capture, use and storage projects. New technologies, like LEILAC, are required urgently to meet the very challenging climate objectives which are unlike anything industry has experienced to date.
- Regular dialogue between local government and local projects are required to achieve a common understanding of the unprecedented challenge of climate change and the requirements for solutions to be effectively and rapidly rolled out.
- Sharing experiences and views widely, across industry, regulators, governments, technologies, sciences, NGOs, and public bodies, can be challenging – but always of use to everyone involved.

More information

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- **https://www.euronews.com/2020/03/16/capturing-co2-how-to-reduce-carbon-dioxide-emissions-from-the-cement-industry**
- **https://www.50climateleaders.com/heidelberg-cement-our-road-to-carbon-neutrality/**