A concrete step forward: Australia's ambitious plan to cut cement and lime emissions

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It's tough for the cement and lime business to make its important products without generating high emissions. So, the industry is investing

in research and innovative pathways to reduce its hard-to-abate emissions.

To help, we've brought our expertise to a new roadmap.

It sets out the opportunities and challenges for carbon capture, utilization and storage (CCUS) technologies to reduce the industry's emissions in Australia. It also determined that there is no one-size-fits-all solution.

The Heavy Industry Low Carbon Transition Co-operative Research Center (HILT CRC) commissioned the "Roadmap for Carbon Capture, Utilization and Storage for Production of Low Emission Cement and Lime in Australia." We worked with Adbri, The University of Adelaide, Calix, UNO Technology, and the Cement Industry Federation (CIF) to develop the roadmap.

Dr. Hai Yu is a Principal Research Scientist at CSIRO and the roadmap co-author.

"HILT CRC has been focusing on how hard-to-abate industries like cement, lime, alumina, iron and steel can reach net zero emissions by 2050. This work requires deep collaboration between industry, universities and research organizations like CSIRO," Hai said.

"CCUS is going to be absolutely critical in the cement and lime industries. Our aim with this roadmap is to move the research forward and help industry stakeholders find the best technology options for them," he said.

Why is the cement and lime industry so hard to decarbonize?

Cement is a binder material used in concrete, mortar and other construction materials. Its key ingredient is clinker. Clinker is made under high temperatures from raw materials like limestone and clay.

When cement is mixed with water, sand and aggregates, it turns into concrete. Concrete is the most common construction material in the world. Iconic buildings such as the Sydney Opera House, Burj Khalifa and Pantheon owe their form to concrete. Globally, people use 30 billion tons of concrete each year.

Lime is made by heating limestone. This important chemical is used in metallurgy, industrial applications and construction. In 2021, the estimated total global production of lime was 430 million metric tons (Mt).

The cement and lime industries are vital. In Australia, it takes about 14 tons of cement to build a typical family home. Also, a kilometer of freeway contains as much as 2,500 tons of cement. However, the industry is one of the hardest to abate.

"Most emissions are not from energy use, but from carbon dioxide (CO_2) that is released when heating limestone to form calcium oxide. This means they are from the process itself rather than from heat energy or electricity generation," Hai said.

"When you talk about a coal-fired power station, for example, we know burning coal produces CO_2 but there are alternatives. We can use solar or wind to generate renewable electricity without creating those emissions.

"When it comes to producing cement, there is not a large-scale alternative. We can't produce it without creating CO_2. That's why carbon capture and storage is necessary and important for reducing these

'process' emissions," he said.

In 2021, world-wide emissions from making cement produced about 2.9 billion tons (2.6 billion metric tons) of CO_2. For perspective, if the cement industry was a country, it would be the fourth largest national emitter in the world, behind China, the US and India.

In Australia, cement production emitted 4.7 Mt of CO_2 in 2020–2021. About 60% of those emissions were process emissions.

Key findings of the CCUS roadmap

We engaged with industry to identify Australian cement and lime plants that can adopt CCUS technologies. This included a review of potential sequestration and use sites as well as transport infrastructure requirements.

We also assessed priority options and identified which ones needed further research.

The CCUS technologies we selected for further analysis were:

- capture technologies. This includes post-combustion capture based on liquid absorbents, calcium looping and cryogenic processes as well as Calix's LEILAC for retrofit applications
- CO_2 conversion to fuels, chemicals and carbonates
- CO_2 transport by pipeline and shipping for geological storage.
- Hai said there are two takeaway messages from the roadmap.

"The first is CCUS requires deep collaboration—both nationally and internationally—between industry and researchers.

"The second is that the best way for companies to learn is by doing. That

doesn't mean you have to spend millions of dollars on something right away that may not work. You can take a low-risk approach, like a feasibility or pilot plant study.

"Ultimately, CCUS is going to be the most important method for reducing emissions in the sector. So, it's time to start getting ready for the future."

Margie Thomson, CEO of the Cement Industry Federation (CIF), recognized the roadmap's findings and contribution to the sector.

"The roadmap is a welcomed addition to the Australian cement industry's ongoing efforts to lower emissions and reach net zero by 2050," she said.

Bridging knowledge gaps with the Australian CCUS roadmap

The cement and lime industry has been researching and developing CO_2 capture technologies since 2007. However, most of this work has happened in Europe and North America. These regions have different industrial, regulatory, geographical, economic and technological circumstances.

This roadmap starts to fill in knowledge gaps by setting out potential approaches for CCUS in the cement and lime industries, specifically for Australia.

In 2020–2021, Australia produced 5.3 Mt of clinker, 9.6 Mt of cement, and 1.5 Mt of lime. The largest cement and lime plants in Australia emit CO_2 at a level that makes them subject to the Australian Government's Safeguard Mechanism. So, they must reduce their emissions in line with

national climate targets.

Hai and the roadmap project team took a comprehensive approach conducting desktop research, industry engagement and workshops, and site visits.

"We also drew upon CSIRO's many decades of experience working on CCUS research," Hai said.

"Through this roadmap we can share what we have learned. CIF and HILT CRC member companies can use our findings to identify their preferred technological options," he said.

Jenny Selway is the CEO of HILT CRC. She said they were thrilled to commission and support this work.

"The dedication and collaboration exhibited by Hai and the research team on this project has resulted in valuable insights that will shape the future of further research into CCUS technologies in cement and lime production."

"The knowledge gained will ensure we remain at the forefront of decarbonizing the cement and lime industry to help reach net-zero emissions by 2050," she said.

You can read a summary of the report.

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