Daniel Rennie
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TO: California Air Resources Board
FR: Leilac US, Inc.
RE: Comments in Response to October 20, 2022, Kick-Off Workshop for Net-Zero Emissions Strategy for the Cement Sector

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Leilac would like to thank California's Air Resource Board (CARB) for the opportunity to comment on the October 20th workshop initiating discussions and planning on the implementation of SB596.

Leilac, aims to apply a breakthrough in low-cost carbon capture technology that will enable the cement and lime industries to reduce their emissions dramatically - while retaining their international competitiveness – by capturing those process emissions at low cost. This is a completely new 'type' of carbon capture technology: Leilac is a "process modification" approach, as opposed to other forms of carbon capture that require additional chemicals or processes. Our technology simply stops the unavoidable CO_2 process emissions from being contaminated during these 'hard to abate' industrial processes. It uses simple, heated tubes that keep the CO_2 pure. As no additional energy or chemicals are required, it can do so at a very low cost.

The technology is currently being applied to capture 20 percent of a plant's emissions as a retrofit. The design is modular and can be applied to cover all of a plant's process emissions. It is being designed to use any fuel or energy source – providing a 'future-proof' solution. This technology is a practical and affordable pathway for local industries to thrive in a carbon-constrained future.

Leilac is supportive of the steps California is taking to decarbonize industrial processes. Leilac believes that governments have a key role to play in solving emissions challenges and appreciates the opportunity CARB is providing to coordinate with companies and other stakeholders to implement long-term incentive frameworks and public financing opportunities.

We welcome the opportunity to serve as a resource to the agency to provide further information or answer any questions that may arise.

Sincerely,

Daniel Rennie
Chief Executive Officer

Introduction

The cement and lime industries play a vital role in our society. Cement is used in our roads, buildings, homes, offices, and almost all infrastructure. Lime is used in a variety of applications, including the iron and steel, chemical, paper, pharmaceutical, drinking water, food, and farming industries. However, the cement sector is responsible for 8% of global CO_2 emissions, most of which are CO_2 emissions released directly and unavoidably from the processing of the raw materials.

Until very recently, there were no technologies or policy mechanisms available to support wholesale decarbonization efforts globally – but that has changed. Today the global cement and lime industries are both committed and developing the tools to take dramatic steps in achieving net zero production. Leilac supports CARB's work to advance technologies that will be vital to improving climate change mitigation and adaptation success.

About the Leilac Technology

This new type of carbon capture technology is specifically designed for the cement industry, ensuring a clean stream of unavoidable process CO_2 is captured, and operating with almost no energy cost and minimal capital cost.

Fast Facts

- It is an extremely simple technology, based on using heated tubes to contain the process CO_2 released from the minerals and stop it from being contaminated by fuel or air. Its unique process of 'indirect calcination' ensures that the relatively pure, unavoidable, CO_2 released from the limestone is available for direct capture.
- It can be retrofitted or integrated into a new plant and applied in a modular approach.
- The technical risks are low, with a demonstration plant due to start construction in 2023 that will capture approximately 20% of a cement plant's emissions (100ktpa).
- The design is future proof and heat source agnostic, enabling the potential use of any fuel – including renewable electricity and hydrogen.
- Quite uniquely for a capture technology in this space, the system requires very little (and often no) additional energy or chemicals, keeping the capital and operating costs very low.
- It offers high CO_2 abatement potential, as it does not need additional fuel to be used to power the capture process and is highly efficient.

The Leilac system has been developed over the course of 15 years and is approaching the point of large-scale application. The core system is proven; the critical next step is for proven large-scale integration with a host plant, on a variety of energy sources – which is currently underway.

Leilac 1, a pilot project funded by the EU's Horizon 2020, was successfully constructed on time and within budget in 2019. The project has been supported by a consortium of key cement and lime industry partners, with HeidelbergCement hosting the pilot-scale project at a cement plant in Belgium. The pilot has the capacity to separate 25,000 metric tons of CO_2 per year. The project has successfully demonstrated that both limestone and raw meal can be processed; that

the CO_2 is successfully separated; and that (disaggregated from the entire system) the energy penalty for indirect calcination (Leilac) should not be higher than direct (conventional) calcination.

Leilac2 commenced in April 2020 and plans to demonstrate the technology at a larger scale – 20% of plant emissions. This demonstration project will be hosted at the HeidelbergCement plant in Hannover, Germany, and aims to separate 100,000 metric tons per year of CO_2 in a scalable module. The Leilac2 project passed its financial investment decision (FID) in March 2022 and is set to become operational in 2024. It is being designed in a module that can scale to 100% of a plant's total emissions, for possible operation in 2025.

There are minimal technical risks associated with the Leilac technology given its stage of development. The primary risk is associated with application at full scale in the most efficient way possible while ensuring that the design can be quickly and cheaply applied to all cement plants.

A demonstration plant and full-scale application in the US would significantly enable the remaining technological risks to be addressed, ultimately enabling rapid decarbonization of the cement industry at large.

Avoiding Process and Fuel Combustion GHG Emissions

Currently, cement production has two sources of carbon emissions: naturally occurring carbon released from limestone and carbon emissions from the energy and heat required to operate the cement production facility. During October 20th workshop, CARB outlined that 59% of the cement sector emissions in the state of California stem from process emissions, while fuel combustion accounts for 36%.[1]

CCUS solutions will play a critical role in reducing process emissions. Leilac encourages CARB to incentivize both carbon abatement or avoidance and carbon capture projects to establish a market for technologies that reduce overall emissions created. As noted above, Leilac's solution offers a completely new 'type' of carbon capture technology by way of modifying the method for processing limestone. While many existing policies in North America reward projects that capture high volumes of CO_2, and those programs have positive impacts, technologies and solutions that prevent emissions at the source should be incentivized as well.

To account for the fuel combustion emissions the energy and heat requirements for the Leilac technology can come from renewable electricity, renewable biomass, or other zero-carbon fuels - particularly clean hydrogen.
Three electric units using this approach (at a small scale) have been made, with a fully electric 25ktpa of CO_2 capacity being the next step.

Prioritizing Environmental and Energy Justice

[1] Source: CARB SB596 Kickoff Workshop Slides, October 20th.

Leilac understands the importance of strengthening environmental justice initiatives. Currently, communities local to cement plants experience disproportionate emissions and public health challenges. Leilac projects are designed for enabling local industries to continue operating at low cost, providing a just transition for industry and society to a low-carbon future. Disadvantaged communities can benefit from the emissions reductions enabled by the Leilac technology while retaining industry and reinforcing critical infrastructure without health or environmental trade-offs.

For all greenhouse gas reduction projects, it is critical to ensure that there is not a tradeoff between reducing carbon emissions and increasing criteria pollutant emissions. For more traditional/standard carbon capture technologies, CARB should require that controls for criteria pollutants be included in the project plans. One of the benefits of the Leilac solution is that it enables a relatively pure stream of CO_2 to be captured. Therefore, an amine system is not required, and very few, and often no, other additional energy or chemicals are required to capture the unavoidable process emissions. Furthermore, our technology is heat-source agnostic, enabling full decarbonization, as well as further reductions in criteria pollutant emissions due to the ability to switch from a fossil heat source to a zero-emission heat source.

Because Leilac does not require additional energy or chemicals, this solution provides a practical and affordable pathway for local manufacturing and industrial facilities to thrive in a carbon-constrained, equitable future.

Challenges to Deployment

One of the primary challenges for the deployment of CCUS solutions in the cement industry is a lack of suitable infrastructure or funding for transport and storage options. The regions that are most likely to decarbonize are those that have rich natural oil reserves or significant existing infrastructure. The Leilac Roadmap[2] indicates that for an overall Leilac CCS installation, by far the largest cost will (for the first time) be the transport and storage components. Given that these are costly and often large infrastructure developments, most will be outside of both the understanding and financial capabilities of cement industry stakeholders. Such a dependency on unregulated transport and storage assets may be a limiting factor in deployment – either due to artificially inflated costs or monopolies that restrict access to certain players.

Low-cost decarbonization options, and the associated infrastructure that can ensure those emissions are not released into the atmosphere, will improve air quality, local employment, and reduce local costs. Without support for the transport and storage of CO_2 from the State, facilities will face increasing pressure to economically transport and store CO_2.

Additionally, a Leilac unit could be built at any scale within 3 years from a technical point, but permitting is completely site-dependent and may extend project timing. State government support to help expedite and ease this process will place projects in operation faster.

[2] Leilac, Leilac Technology Roadmap to 2050, September 2021

Leveraging State and Federal Funding

Leilac is very excited to see increasing support in the U.S. across a variety of economic incentives, including loans, grants, tax credits, and technical assistance programs, for carbon capture technologies. The main risk for Leilac is associated with validating full-scale, commercial operations. Full-scale commercial operations, particularly at a fully integrated retrofit, carry some technical and production risks, and without incentives like the federal Section 45Q tax credit or financing support through to a final investment decision (FID), it is difficult to build a business case.

Tax credits can provide the long-term guarantees needed to ensure a project's success. Funding to support development costs through to FID, through grants and other cost-sharing arrangements, greatly reduce project risks for industrial decarbonization projects, as sectors like cement and lime production are typically low-margin, conservative markets. In the case of Leilac, the main costs are CAPEX for the capture unit's build and OPEX for compression and offtake agreements for storage.

In combination with one another, these incentives improve market demand in the U.S. for low-carbon projects, attract more green developers, and foster clean energy jobs.

Conclusion

Again, Leilac would like to thank CARB for the opportunity to provide comments on the October 20th workshop and is supportive of the steps California is taking to decarbonize industrial processes. We welcome the opportunity to serve as a resource to the agency to provide further information or answer any questions that may arise.