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SB 596 Cement Sector Net-zero Emissions Strategy Kick-off Workshop
Comments from World Resources Institute
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We would like to thank California Air Resources Board (CARB) staff and other presenters at the October 20, 2022, *SB 596 Cement Sector Net-zero Emissions Strategy Kick-off Workshop* for the informative presentations on cement decarbonization. We appreciated hearing CARB staff's approach for developing the comprehensive strategy for achieving the goals of SB 596 that is due by July 1, 2023, and the detailed information on decarbonization approaches available for the California cement industry.

The workshop presentations provided a solid overview of the types of technologies and processes that will need to be adopted for California to meet the net-zero emissions target in SB 596. These approaches will require significant investment to implement, so CARB should consider policies that provide strong economic and regulatory incentives to speed up those investments. We offer the following comments on behalf of World Resources Institute (WRI) to recommend the inclusion of a low-carbon cement standard (LCCS) as an important element in California's comprehensive SB 596 strategy. An LCCS would reward companies that do the most to reduce their GHG emissions from producing cement used in California while making business-as-usual operations more expensive. This would provide a strong incentive for companies to invest in the breakthrough technologies needed for deep greenhouse gas emission reductions such as those presented in the workshop.

WRI has previously described how one could design a national LCCS.[1] In the comments below we explain the basics of how an LCCS would work and highlight some key considerations for how one could be implemented in California. We welcome the opportunity to discuss this approach in more detail with CARB staff and with any interested stakeholders who are following the SB 596 implementation process.

What is a Low-Carbon Cement Standard?

A low-carbon cement standard is modeled on California's low-carbon fuel standard (LCFS). It includes a few key elements:

- an emissions intensity metric, generally speaking tons of CO_2e emissions per ton of cement produced, and emission and production reporting rules for cement producers and importers;
- an emissions intensity benchmark; and
- a credit system, with cement used in California that was produced with a lower emissions intensity than the benchmark earning credits, while cement with a higher emissions intensity owing credits.

[1] Fransen, T., et al. 2021. "Toward a Tradable, Low-Carbon Cement Standard: Policy Design Considerations for the United States." Working Paper. Washington, DC: World Resources Institute. Available online at doi.org/10.46830/wriwp.20.00112.

In looking at how a national LCCS could work, we focused on tradeable credits, similar to the LCFS credits. Those that earned credits could sell them and earn revenue, while those who owed them would need to buy them on the market. That approach can work well when there are enough participants to ensure a liquid market. Since the California cement market has very few active players, an alternate feebate approach may make more sense. In this approach, California would effectively set a price for the credits that it would charge to those owing credits or refund to those earning credits.

An important element of the LCCS is that it would apply not just to cement produced in California, but also to cement imported from other states or countries. This feature addresses the concerns that applying strong regulatory measures to the California cement industry would simply lead to an increase in imported cement. While existing mandatory GHG reporting rules could be used to gather the needed data for cement produced in the state, additional reporting requirements would need to be placed on cement importers.

A simple example can illustrate how the LCCS could work in practice, as shown in Table 1 below. We use four example plants. Because the LCCS would apply to imports as well as cement produced in California, these plants could be either inside or outside California.

The first two hypothetical plants are based on 2008 data from the initial rulemaking for the California cap-and-trade program regulations.[2] Data for the nine cement plants then operating in California showed a range of emissions intensity from just below 0.8 metric tons (MT) CO_2e/MT clinker adjusted for mineral additives (MT/MT) to just above 0.9, with a median value of approximately 0.85. While out of date, this data gives a sense of how emissions intensities vary across California's cement plants. We the two extremes as two example plants (Plant A at 0.9 MT/MT; Plant B at 0.8 MT/MT).

We then take inspiration from the two breakthrough technologies presented at the workshop, again for illustrative purposes. As a stand-in for a plant using the Rondo technology to provide all the heat needs, we assume about a 40% reduction in emissions for the median plant above, so an emissions intensity of 0.5 MT/MT for our hypothetical Plant C. For an illustrative plant using the Brimstone technology, which the company claims could produce Ordinary Portland Cement with negative emissions, we use zero emissions for our hypothetical Plant D.

We then present two scenarios using different benchmarks to show how the incentives shift. We use the median (0.85 MT/MT) as our illustrative benchmark in Scenario 1 and 0.5 MT/MT (approximately 40% below the median) for Scenario 2.

The economic incentive comes from how the plant's emissions intensity compares to the benchmark. For the two plants based on conventional technologies in our example, the intensity is close to the Scenario 1 benchmark, so the economic cost or benefit is relatively small. However, for plants with innovative technologies that achieve significant emission reductions, the resulting revenue per ton of cement can be significant. For the lower benchmark in Scenario 2, the cost of continuing at existing emissions intensity increases, while the relative incentives between the plants with higher and lower emissions intensity remains the same.

[2] *Development of Product Benchmarks for Allowance Allocation*, Appendix B to the July 25, 2011, Notice of Public Availability of Modified Text and Availability of Additional Documents. See https://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm

Table 1: Illustration of how a low-carbon cement standard would work under two benchmarks

	Plant A	Plant B	Plant C	Plant D
Emissions (MMT CO_2e)	1.35	0.60	0.25	0.00
Cement production (MMT)	1.50	0.75	0.50	0.25
Emissions intensity (tons CO_2e/ton cement)	0.9	0.8	0.5	0.0
Scenario 1 Illustrative benchmark of 0.85 tons CO_2e/ton cement and credit price of $100				
Difference from benchmark *= benchmark – emissions intensity*	(0.05)	0.05	0.35	0.85
Credits (thousands) *= tons of cement * difference from benchmark*	**(75.0)**	**37.5**	**175.0**	**212.5**
Total earned ($M)	(7.50)	3.75	17.50	21.25
Earned per ton cement	**($5)**	**$5**	**$35**	**$85**
Scenario 2 Illustrative benchmark of 0.5 tons CO_2e/ton cement and credit price of $100				
Difference from benchmark *= benchmark – emissions intensity*	(0.40)	(0.30)	0.00	0.50
Credits (thousands) *= tons of cement * difference from benchmark*	**(600.0)**	**(225.0)**	**0.0**	**125.0**
Total earned ($M)	(60.00)	(22.50)	0.00	12.50
Earned per ton cement	**($40)**	**($30)**	**$0**	**$50**

Note: the emissions intensity for Plants A and B and the illustrative benchmark in Scenario 1 are based on data from 2008. Current emissions intensities for California plants may be lower than for A and B, and an initial benchmark would also likely be set lower than in Scenario 1.

The incentives under the LCCS are similar to those provided under the cap-and-trade program if free allowance allocation happens at the level of the LCCS benchmark and the allowance price equals the LCCS credit price. The credits owed or earned above are equivalent to allowances owed or earned after accounting for the free allocation.

However, the LCCS could provide a stronger incentive to invest in cement sector reductions than cap and trade for two key reasons. First, the cap-and-trade allowance price is tied to the marginal cost of emission reductions across the California economy and may not be high enough to encourage the significant investments needed to decarbonize the cement sector. The LCCS credit price would be more directly tied to the costs associated with meeting the net-zero emissions goals of SB 596. The experience with the LCFS is instructive here – LCFS credits have consistently traded for multiples of the cap-and-trade allowance price. Even with a significant price decline in 2022, LCFS credits in mid-November are

trading above $60[3] while the August cap-and-trade auction sold allowances for $27, near their peak.[4] These LCFS credit prices have provided alternative fuel providers much stronger incentives than the cap-and-trade program would have alone. Similar incentives under a LCCS could help drive investment in innovative approaches to cement sector emission reductions. In addition, the fact that the LCCS would cover imported cement as well as cement produced in California means that there is little reason to fear that a high LCCS credit price would undercut California producers and lead to emissions leakage by encouraging imports.

Design Issues for a California LCCS

Who is covered by the LCCS? California's cement producers and importers would be covered. In addition to the state's seven operating cement plants, the LCCS would also cover whoever owns the cement when it is brought into the state for sale or use. Existing reporting requirements for California cement producers would need to be expanded to include those with imports over a given threshold. Importers would need to report both the amount of cement imported and the emissions from production of the cement. How to get emissions data on those imports is discussed below.

How is cement defined for the LCCS? During the workshop, CARB staff noted that cement is defined under the mandatory reporting rules and cap-and-trade regulation as "a building material that is produced by heating mixtures of limestone and other minerals or additives at high temperatures in a rotary kiln to form clinker, followed by cooling and grinding with blended additives. Finished cement is a powder used with water, sand and gravel to make concrete and mortar." [5] Since cement can vary in the raw materials used and its clinker-to-cement ratio, the product covered by the LCCS can't simply be 'cement' but requires a more specific definition. For example, the California cap-and-trade program defines a product benchmark for the cement industry based on clinker plus added limestone and gypsum.[6]

The clinker plus mineral additives approach used in the cap-and-trade program provides a good starting point for a LCCS, but consideration will need to be given to the inclusion of SCMs in cement production, novel cements that use different underlying chemistries, and other emerging decarbonization approaches that diverge from current industry practices. The critical point will be to ensure the definition of cement used for the calculation of the emissions intensity of the product results in a system that provides clear economic incentives for reducing the GHG emissions from the use of cement.

What emissions are covered? Incentives and requirements for buying low-carbon manufactured products typically focus on life-cycle emissions. This approach is critically important for concrete since about 80% of the emissions come from the upstream production of cement. When designing a low-carbon product standard focused on *cement*, though, the life-cycle focus is less important since most of the emissions from cement use are from the production process itself, rather than upstream emissions from quarrying the limestone, for example. Consideration should be given to the emissions associated with shipment of cement to its point of use. These emissions will be significantly higher for imported cement, so their inclusion may be important for creating a level playing field between cement produced

[3] https://www.neste.com/investors/market-data/lcfs-credit-price, accessed November 18, 2022.
[4] CARB Auction Settlement Prices and Results Summary.
[5] https://ww2.arb.ca.gov/sites/default/files/2022-10/nc-SB%20596%20Kick-Off%20Workshop%20CARB%20Staff%20Presentation.pdf
[6] https://ww2.arb.ca.gov/sites/default/files/2021-02/ct_reg_unofficial.pdf#page=6

in California and imported cement. Whether to include upstream emissions or the emissions associated with electricity used at cement plants should balance the need to reduce those emissions with the additional administrative requirements that would arise from expanding reporting to include them in a reliable and verifiable manner.

Because more than half of the emissions from making cement come from the chemical process of making clinker from limestone, carbon capture, utilization, and storage (CCUS) is often seen as an important tool for decarbonizing cement. The LCCS could exclude emissions that are captured and permanently stored in geologic formations.

How to get good data for imports? In recent years, a significant amount of California cement imports have come from a range of countries, including China, Egypt, Mexico, South Korea, Turkey, Thailand, and Viet Nam.[7] While the California Air Resources Board (CARB) and the U.S. EPA have mandatory reporting rules that require cement producers in California and across the country to report both GHG emissions and cement production, comparable data may be difficult to come by for many imports.

California would need to evaluate different approaches for data availability and reliability. A possible example to follow is the federal Clean Competition Act.[8] This proposed legislation by Senator Whitehouse would create a U.S. border carbon adjustment for imported industrial products and would differentiate between countries with transparent verifiable data reported to national governments and those with more opaque GHG reporting. For the latter, the relative economy-wide GHG emissions intensity of the country compared to the U.S. emissions intensity would be the basis for estimation. Other initiatives are underway to develop common, transparent standards for reporting on the emission intensity of products including cement, that could provide additional guidance. These include the Industrial Deep Decarbonization Initiative,[9] sectoral initiatives like the Global Cement and Concrete Association's Getting the Numbers Right (GNR) database,[10] and the EU's Carbon Border Adjustment Mechanism.[11]

Where should the benchmarks be set? With SB 596, California set a trajectory for decarbonizing the use of cement in the state. It set an interim target of reducing the GHG intensity of cement used in California by 40 percent from 2019 levels by 2035 on the way to the net-zero emissions target for 2045. It also includes an evaluation of feasibility to reach this interim target in 2028 with the option to revise the target upward or downward at that point. The LCCS could use those targets to establish its annual benchmarks, following a linear decline from the 2019 value through a 40 percent decrease in 2035, then following a slightly steeper straight-line decline to zero in 2045. Since technological development and readiness underpins many of the deeper decarbonization options, an LCCS could include a similar evaluation of feasibility and make adjustments in part based on technology development of relevant decarbonization options.

How should credit price be set in a feebate version of the LCCS? In an LCCS with tradeable credits, the credit price would be set by the supply and demand in the market. As noted above, though, a California-

[7] Based on data from USA Trade Online.
[8] https://www.congress.gov/bill/117th-congress/senate-bill/4355?r=8&s=1
[9] https://www.cleanenergyministerial.org/initiatives-campaigns/industrial-deep-decarbonisation-initiative/
[10] https://gccassociation.org/sustainability-innovation/gnr-gcca-in-numbers/
[11] https://taxation-customs.ec.europa.eu/green-taxation-0/carbon-border-adjustment-mechanism_en

only LCCS may lack enough participants to keep the market liquid, so a feebate approach in which California establishes the price of the credits may make more sense. With this approach, CARB would need to determine the initial credit price and how it would change over time.

One approach could be to base the price trajectory on the expected cost per ton to decarbonize the cement used in California. The analysis needed to do this could also help inform the trajectory chosen for the benchmark. An assessment of the technological readiness of different options would need to include estimates of both the cost of different mitigation options and the speed at which they could be deployed.

A second option could be to base the credit price on the social cost of carbon (SCC). The U.S. Environmental Protection Agency recently put out new estimates for the SCC for external review, with estimates for the social cost of CO_2 ranging from $120 to $340 per ton, depending on the discount rate used, for emissions in 2020, increasing to $170 to $430 per ton for emissions in 2040.[12]

Conclusion

California has set out to be a pioneer in decarbonizing the cement industry, establishing a net-zero emissions target for cement used in the state by 2045. Achieving that target will require significant public and private investments that rapidly develop and deploy low-carbon technologies and processes to reduce emissions from making cement. A low-carbon cement standard offers a potentially potent policy tool to drive those investments.

We thank CARB staff for their work on implementing SB 596 and welcome the opportunity to discuss the possible role of a low-carbon cement standard in meeting its ambitious target.

Sincerely,

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[12] U.S. Environmental Protection Agency, National Center for Environmental Economics. "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances," external review draft, September 2022. Available at: https://www.epa.gov/environmental-economics/scghg