AMERICAN ECONOMIC LIBERTIES PROJECT

A Better Foundation: Addressing Consolidation in the Cement and Concrete Industries to Secure Low-Carbon Alternatives

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EXECUTIVE SUMMARY

The cement and concrete industries in the United States are dominated by large incumbents. Due both to the dearth of competition and to inertia among government agencies, these incumbents receive the bulk of public procurement contracts. Dominant firms also lead an ecosystem of engineers and construction professionals in the standard-setting process. Both the procurement and standard-setting processes are key bottlenecks slowing the decarbonization of cement and concrete.

Though most cement incumbents acknowledge the need to reduce emissions, the consolidated nature of the industry minimizes their incentive to innovate. Thus, dominant firms' investments amount to procrastination: they are focused on demonstrating the potential of low-carbon technologies but not on commercializing and deploying them.

Despite the consolidated nature of the cement and concrete industries, new firms have emerged. Capital is flowing to these entrants from dominant cement companies, as well as from energy and technology monopolies. While capital investment is a hopeful sign of the potential of low-carbon cements and concretes, there are also signs that dominant firms are acquiring or investing in smaller, cleaner companies merely to thwart them or to lock up intellectual property. Antitrust enforcers and procurement officers should scrutinize future mergers and contracting among dominant firms to ensure they do not engage in "killer acquisitions" or consolidate intellectual property without deploying it.

Policymakers should also make efforts to build a stronger and more competitive cement and concrete market. This can be accomplished by updating procurement criteria to incentivize and preference low-carbon cements and concretes, and to encourage performance-based standards.

Photo credit: Yogendra Singh

INTRODUCTION

When the Biden administration launched its American Jobs Plan this spring, it made clear that changing the way Americans use and build infrastructure is fundamental to meeting U.S. climate and emission goals. It is no surprise, then, that the administration's infrastructure plan includes a commitment to using cleaner cement and concrete and to reducing emissions from the industrial facilities that produce these and other materials.[1] The cement industry alone accounts for upwards of eight percent of global carbon emissions.[2] Unless we take meaningful steps to decarbonize it, the U.S. will not reach net-zero carbon emissions—and policymakers will lock the nation onto a higher-emissions pathway for decades to come.

Fortunately, there are ample technical means for reducing cement and concrete emissions. Component materials may be reduced or substituted to lower emissions from the process of making cement and concrete. New low-carbon cement alternatives can replace cement. And emissions from cement-manufacturing facilities can be captured, including the emissions from making novel cements and concretes.

Unfortunately, the cement industry is dominated by a handful of large producers with market power. In part because of this market power, the majority of these firms have done little to deploy low-carbon cement technologies, validating what Nobel-prize winning economist John Hicks once noted: "the best of all monopoly profits is a quiet life." Cement incumbents have shaped an industry where they have little incentive to innovate.[3] Incumbents are closely intertwined with the bodies that establish the standards and codes that largely determine which cements and concretes are used in construction projects. To the extent incumbents are exploring low-carbon cements, they have not commercialized them at scale. And the regional, low-margin nature of the industry—and the decisions made by the public procurement officials whose purchasing decisions drive it—means there are few incentives for competitors to enter the marketplace.

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1 Press Release, Fact Sheet: The American Jobs Plan, White House (Mar. 31, 2021), https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/.

2 Jos G.J. Olivier et al., Trends in Global CO2 Emissions: 2016 Report, The Hague: PBL Netherlands Environmental Assessment Agency, 64-65 (2016), http://edgar.jrc.ec.europa.eu/news_docs/jrc-2016-trends-in-global-co2-emissions-2016-report-103425.pdf.

3 J.R. Hicks, Annual Survey of Economic Theory: The Theory of Monopoly, Econometrica, Volume 3, Issue 1 (Jan. 1935), 8.

Policymakers have largely ignored the concentrated nature of the cement industry. Until recently, they have similarly neglected industrial carbon pollution, focusing instead on lower-hanging emissions-reductions fruit. That is beginning to change. The cement industry's enormous contributions to climate change, combined with the growing momentum toward federal infrastructure investment, have brought needed attention to construction's contributions to global climate change. Restructuring the cement industry should be a core part of an industrial decarbonization strategy, increasing competition in the economy while addressing the climate crisis. This report briefly summarizes barriers to and strategies for doing so.

Part I describes the technological pathways to decarbonize cement and concrete. Part II outlines the existing U.S. cement market, explaining both how it is dominated by a small number of large players and how, despite consolidation, new firms have recently entered the marketplace. Part III discusses structural barriers to decarbonization, including procurement, prescriptive standards, and the consolidation of intellectual property by dominant firms. Part IV recommends policy solutions for creating a more competitive cement and concrete market, where more low-carbon firms can enter and successfully commercialize their products, as has been done on a small scale in Hawaii and California.

* * *

I. CEMENT & DECARBONIZATION

Cement is the key ingredient in concrete, the most widely used construction material in the world. The majority of cement is used in commercial construction, and the standard type is known as Portland cement. Portland cement is predominantly comprised of Portland clinker, which is manufactured from limestone, clay, gypsum, supplementary cementitious materials, and fillers.

The process of grinding and heating Portland cement components produces substantial carbon emissions. Fuel is combusted to generate the heat necessary to manufacture cement, releasing carbon.[4] The chemical reaction that occurs when limestone calcinates generates even more carbon. Thus, the embodied emissions of cement—how many greenhouse gases are emitted when cement is produced—is largely a product of how much Portland clinker is used to make it. And because Portland cement is currently used in 98 percent of all concrete produced, reducing or replacing Portland clinker can produce enormous reductions in industrial carbon emissions.

4 Id.

Therefore, beyond making the overall production process more efficient and using alternative fuels, there are three essential pathways to reduce the embodied emissions of cement:

1. **Reduce the amount of Portland clinker used.** Portland clinker can be replaced with a greater quantity of supplementary cementitious materials and fillers. Substitutions change the chemical properties of the cement, making some consumers reluctant to purchase them. But "high-blend" cements are already safely and widely used in U.S. markets for reasons that have nothing to do with climate. Indeed, high-blend cements can lead to advantages in construction and be less expensive to produce than Portland cement. This is because manufacturers use whatever industrial waste is locally available—chalk, rock mining waste, fly ash or slag, recycled glass—as substitutes for clinker. Moreover, clinker may be reduced without investing in alternative equipment or fuels, allowing manufacturers to deploy substitution quickly and cheaply.

2. **Use novel cements and concretes.** Novel low-carbon cements are produced through novel technological processes. Some replace all or nearly all of the Portland clinker with alternatives that mimic its properties but produce much less carbon. Others sequester carbon as part of the manufacturing process, for example, by using CO2 to cure concrete, a process dubbed CO2 mineralization. Again, some low-carbon cements enhance the properties of concrete; CO2 mineralization, for example, can increase concrete's strength.[5]

3. **Capture cement and concrete emissions.** Even if clinker substitution and novel cements are widely adopted, cement manufacturing will still generate significant emissions. Capturing emissions from the cement kiln would substantially reduce the industry's carbon footprint, as well as the overall footprint of the communities where kilns are located.

All three strategies must be adopted at scale to achieve meaningful carbon reductions, especially given projected increases in demand from developing nations. In the immediate term, clinker substitution is likely the most promising path to lower emissions; it can be implemented quickly and at low cost, without fundamentally changing how cement is made. Concentration in the cement and concrete markets limits all three, however, and the most important public policy solutions are technology-neutral. The merits and feasibility of each pathway are discussed and advocated for at length in other scholarship, so although we discuss acquisitions and investments by incumbents relevant to specific pathways, we do not otherwise distinguish between them for the purposes of this paper.

5 See, e.g., Victor C. Li, Bendable Concrete, With A Design Inspired By Seashells, Can Make US Infrastructure Safer And More Durable, The Conversation (May 25, 2018), https://theconversation.com/bendable-concrete-with-a-design-inspired-by-seashells-can-make-us-infrastructure-safer-and-more-durable-93621.

II. MARKET STRUCTURE

The cement industry is largely influenced by location-based demand and infrastructure investment. Covid-19 had a significant impact on construction projects around the country, directly affecting demand for cement, which led to unexpected revenue losses in 2020.

While demand is generally steady, the industry has high barriers to entry due to high upfront costs to set up manufacturing facilities. Both Portland and substitute clinker cement plants operate based on location-specific fixed costs, with substantial capital investments needed to build rotary kilns that are not readily transferable. Even high-blend cements must be produced at scale, benefiting larger producers. Moreover, distant suppliers do not contribute to competition because acquiring cement from them is expensive and transportation is unreliable, especially for larger customers.[6] Given these physical characteristics, some concentration is inevitable; in the U.S., an oligopolistic structure exists at the regional level.

High transportation costs foster vertically integrated supply chains, with mining and cement grinding often controlled by the same company. Vertical integration, in turn, makes it more difficult for smaller firms to enter and compete with larger firms. There is also resistance to major innovation in the supply chain because cement companies have invested in large fleets of cement transportation vehicles and kilns to grind the input materials for production.

Cement manufacturing is a low-margin business, as is the construction industry it supplies, further reducing incentives for startups to enter the market and dominant firms to innovate. Prices are not posted but instead are determined through bilateral negotiation, varying significantly from customer to customer; long-term contracts are rare.[7] Distance and transportation costs are often determinative, and cement suppliers are able to identify customers that face limited competitive options and target them with higher prices.[8] While the concrete industry is fragmented by comparison, with many smaller companies serving local areas, concrete companies nevertheless have little choice but to buy the majority of their cement from a small handful of producers. IBISWorld predicted that roughly 70 percent of cement would be sold to ready-mix concrete producers in 2020.[9]

6 Complaint, In the Matter of HeidelbergCement AG et al., Federal Trade Commission (May 20, 2021), https://www.ftc.gov/system/files/documents/cases/d09402heidelbergcomplaint.pdf.

7 Id.

8 Id.

9 Jeremy Moses, Cement Manufacturing in the U.S., IBISWorld, at 21 (2020), https://www.ibisworld.com/united-states/market-research-reports/cement-manufacturing-industry/.

MAJOR PLAYERS

Five firms control roughly 43 percent of the cement manufacturing industry in the United States. Mexico-based Cemex claims a 17 percent market share; international giant LafargeHolcim claims a 13 percent market share; Martin Marietta Materials and Buzzi Unicem SPA each claim roughly a five percent market share; and HeidelbergCement maintains a 3.5 percent market share.[10] Other firms also have a substantial presence in the cement industry, including CRH plc, a building materials conglomerate.

43%

of the cement manufacturing industry in the United States is controlled by 5 firms.

Globally, LafargeHolcim, HeidelbergCement, and Cemex dominate the cement market.[11] This is the result of significant recent mergers and acquisitions among the firms, including investments in novel cement companies. Together, the three firms reported $61 billion in global revenue in 2019.[12]

LAFARGEHOLCIM

The world's largest cement company, LafargeHolcim is the product of a 2015 merger between the French manufacturer Lafarge and the Swiss manufacturer Holcim. The deal was worth $25 billion and raised antitrust concerns at the Federal Trade Commission.[13] Ordered divestitures included cement plants, quarries, terminals, and other assets in twelve states and locations in Canada.[14]

LarfageHolcim has continued to consolidate through smaller acquisitions, which have strengthened its position as a vertically integrated concrete and cement manufacturer and supplier. In 2018, the firm acquired Tarrant Concrete, a ready-mix concrete manufacturer in Texas. The following year it acquired two Colorado-based ready-mix concrete suppliers, Transit Mix Concrete and Metro Mix LLC. In 2021, LafargeHolcim entered a definitive agreement to acquire Firestone Building Products Company LLC, which would expand its portfolio in the construction supply chain. Firestone is a commercial roofing manufacturer and supplier based in

10 Id. at 35-40.

11 Johanna Lehne and Felix Preston, Making Concrete Change: Innovation in Low-carbon Cement and Concrete, Chatham House, at 5 (2018), https://www.chathamhouse.org/sites/default/files/publications/2018-06-13-making-concrete-change-cement-lehne-preston-final.pdf.

12 Moses, supra note 9, at 35-40.

13 Complaint, In the Matter of Holcim Ltd. and Lafarge S.A., Federal Trade Commission (May 4, 2015), https://www.ftc.gov/system/files/documents/cases/150504holcimcmpt.pdf.

14 Press Release, FTC Requires Cement Manufacturers Holcim and Lafarge to Divest Assets as a Condition of Merger, Federal Trade Commission (May 4, 2015), https://www.ftc.gov/news-events/press-releases/2015/05/ftc-requires-cement-manufacturers-holcim-lafarge-divest-assets.

Nashville, Tennessee, with 15 manufacturing facilities and 1,800 distribution points.

LafargeHolcim has also made investments in emerging cement technologies. Most notably, Lafarge has since 2013 been a major investor in Solidia, a New Jersey-based startup whose cement, it claims, generates 40 percent fewer emissions than Portland cement by using less clinker while also sequestering carbon.[15] In 2015, Lafarge entered an agreement giving the corporation the right to commercialize Solidia technology worldwide.[16] Neither Solidia nor Lafarge has announced major Solidia customers since, beyond commercial pilots. Lafarge recently announced a similar partnership with Schlumberger New Energy to explore carbon capture and sequestration at two of Lafarge's plants.[17]

HEIDELBERG CEMENT

HeidelbergCement already controlled a large share of the U.S. and global cement markets when it acquired top-four cement manufacturer Italcementi in 2016. The $4.2 billion merger raised antitrust concerns at the Federal Trade Commission.[18] Ordered divestments primarily included a cement plant and terminals in West Virginia.[19] The European Commission also examined the acquisition and required Heidelberg to divest operations in Belgium.[20]

Heidelberg has continued to acquire rivals since. Recently, its subsidiary, Lehigh Cement Company, sought to purchase Keystone Cement Company, a direct regional competitor. If consummated, the acquisition would reduce the number of major cement competitors in the eastern Pennsylvania and New Jersey area from four to three, giving Lehigh market share sufficient to unilaterally raise prices or reduce the output or quality of its products. Lehigh and Keystone have until now competed closely on price, to Lehigh's frustration; Keystone is seen as an aggressive and disruptive firm.[21] Moreover, the transaction is an important illustration of how concentration begets concentration in the U.S. cement industry: Lehigh acquired its local plant when Heidelberg purchased Italcementi; one of the two remaining regional competitors would

15 SolidiaTech.com, accessed Apr. 8, 2021, https://www.solidiatech.com/solutions.html. Other major Solidia investors include BP, BASF, and Kleiner Perkins. Although Solidia lists Lafarge as a participant in numerous funding rounds, it is unclear when the first capital investment occurred. The VC Funded Cement Disruptor That's Cracking Concrete's Climate Conundrum, Investable Universe (Dec. 19, 2019), https://investableuniverse.com/2019/12/19/solidia/.

16 Press Release, Lafarge and Solidia Commercialize a New Low-Carbon Solution for the Construction Sector, LafargeHolcim (April 28, 2015), https://www.holcim.com/04282015-Lafarge-Solidia-commercialize-new-low-carbon-solution-for-construction-sector.

17 Press Release, LafargeHolcim and Schlumberger New Energy Explore Carbon Capture and Storage Solutions, LafargeHolcim (Feb. 9, 2021), https://www.lafargeholcim.com/lafargeholcim-and-schlumberger-new-energy-explore-carbon-capture-and-storage-solutions.

18 Complaint, In the Matter of HeidelbergCement AG and Italcementi S.p.A., Federal Trade Commission (June 17, 2016), https://www.ftc.gov/system/files/documents/cases/160617heidelbergcmpt.pdf.

19 Press Release, FTC Approves Final Order Preserving Competition In Five Regional U.S. Markets for Cement, Federal Trade Commission (August 16, 2016), https://www.ftc.gov/news-events/press-releases/2016/08/ftc-approves-final-order-preserving-competition-five-regional-us.

20 Press Release, European Commission Provides Clearance for Proposed Acquisition of Italcementi, HeidelbergCement (May 26, 2016), https://www.heidelbergcement.com/en/pr-26-05-2016.

21 Complaint, In the Matter of HeidelbergCement AG et al., Federal Trade Commission (May 20, 2021), https://www.ftc.gov/system/files/documents/cases/d09402heidelbergcomplaint.pdf.

22 Id.

be Lafarge.[22]

Heidelberg recently announced investments in cement carbon capture and sequestration technology, launching proprietary projects with smaller technology partners.[23] Again, these projects appear limited to pilots.

CEMEX

Cemex became one of the world's largest cement companies when it acquired Australian-based Rinker Group in 2007. It has been hindered in recent years by debt obligations arising from the $14 billion acquisition. To further bolster its U.S. market share, Cemex increased its ownership stake in Lehigh White Cement Company in 2018.[24]

MARTIN MARIETTA

North Carolina-based Martin Marietta entered the cement market by acquiring its down-market rival, Texas Industries Inc., in 2014, for $3 billion.[25] The merger created the largest aggregate producer in the United States.[26] Martin Marietta has since made other acquisitions, including the 2017 purchase of Bluegrass Materials Company for $1.6 billion. An aggregates and concrete block distributor based in Florida, Bluegrass had previously acquired a portfolio of Cemex assets in Kentucky, including seven quarries, three resale distribution centers, and one concrete block manufacturing facility.[27]

In a sign of growing regional consolidation, Martin Marietta also recently announced the purchase of Lehigh Hanson's western cement, aggregates, and concrete businesses from Heidelberg.[28] The sale will complete Martin Marietta's U.S. portfolio—the corporation currently has almost no presence west of Colorado. It also allows Heidelberg to focus on growing its Midwest and East Coast, its "strongest market positions," which Heidelberg intends to continue

23 See, e.g., Press Release, Next Industrial Scale-Up of a CO2 Capture Technology: LEILAC 2 Pilot Project Will Be Located at HeidelbergCement's Hanover Cement Plant, HeidelbergCement (Feb. 1, 2021), https://www.heidelbergcement.com/en/pr-01-02-2021; Breakthrough Technology for Carbon Capture, HeidelbergCement (Apr. 21, 2016), https://www.heidelbergcement.com/en/leilac-research-project.

24 Moses, supra note 9, at 36.

25 Moses, supra note 9, at 38; Competitive Impact Statement, United States v. Martin Marietta Materials, 1:14-cv-01079 (D.D.C. Jun. 26, 2014) ("Customers in the Dallas area have benefited from vigorous competition between Martin Marietta and Texas Industries on price and customer service in the production and sale of Texas DOT-qualified aggregate.")

26 Id.

27 Press Release, Martin Marietta Completes Acquisition of Bluegrass Materials, Martin Marietta (Aug. 30, 2018), https://ir.martinmarietta.com/news-releases/news-release-details/martin-marietta-completes-acquisition-bluegrass-materials.

28 Martin Marietta to Buy HeidelbergCement's Western U.S. Assets for $2.3 Bln, Reuters (May 24, 2021), https://www.reuters.com/business/finance/martin-marietta-buy-heidelbergcements-western-us-assets-23-bln-2021-05-24/; Press Release, Martin Marietta Announces Acquisition of Lehigh Hanson's West Region Business, Martin Marietta (May 24, 2021), https://www.globenewswire.com/news-release/2021/05/24/2234444/0/en/Martin-Marietta-Announces-Acquisition-of-Lehigh-Hanson-s-West-Region-Business.html.

29 Press Release, Major Step in Portfolio Optimization: HeidelbergCement Sells its U.S. West Region Business for USD 2.3 Billion, HeidelbergCement (May 24, 2021), https://www.heidelbergcement.com/en/pr-24-05-2021; Facility Locator, Martin Marietta (accessed Jun. 9, 2021), https://www.martinmarietta.com/facility-locator/.

through “bolt-on acquisitions and capacity expansion.”[29]

CRH PLC

CRH plc is a building materials conglomerate based in Ireland. The company was formed through a merger in 1970 between Cement Limited and Roadstone Limited, two Irish cement companies, and now operates in 30 countries with over 3,000 locations.[30] Following the acquisition of a Utah-based concrete company, Amcor, the company began operating in the U.S. in 1978.[31] CRH plc is now the second-largest ready-mix concrete producer in the country, and owns and operates some of the largest U.S. cement firms, including Ash Grove and Suwannee American Cement.[32] CRH plc’s subsidiary Tarmac was a Lafarge subsidiary until 2015, when it

Photo credit: Deborath Ramos

30 2020 CRH plc Annual Report, https://www.crh.com/media/3548/crh-interactive-annual-report-2020.pdf.

31 CRH, United States (accessed Jun. 9, 2021), https://www.crh.com/global/americas/united-states.

32 Id.

33 Katherine Smale, CRH completes takeover of Lafarge Tarmac, New Civil Engineer (Aug. 3, 2015), https://www.newcivilengineer.com/archive/crh-completes-takeover-of-lafarge-tarmac-03-08-2015/.

was sold to CRH plc in a divestment to gain regulatory approval for the Holcim merger.[33]

NEW MARKET ENTRANTS (NOVEL CEMENT)

Cement and concrete startups are focused on novel technologies. Numerous novel cement and concrete companies have entered the U.S. markets over the past decade. Each researches or sells different technology solutions for lowering emissions from the production of cement or concrete, from carbon sequestration to novel clinker replacements. Notable entrants include:

Startup	Technology/Focus
Svante	Carbon Capture - Cement
SOLIDIA	Clinker Reduction - Cement CO_2 Sequestration - Concrete
CARBON CURE	CO_2 Sequestration - Concrete
ecocem	Clinker Reduction - Cement
CarbonBuilt	Cement Reduction - Concrete CO_2 Sequestration - Concrete
CarbiCrete	Clinker Substitution - Cement CO_2 Sequestration - Concrete
Blue Planet	CO_2 Sequestration - Aggregates

III. STRUCTURAL BARRIERS TO DECARBONIZATION

Unless customers demand innovation or policymakers require it, large incumbents have few incentives to develop and market new or improved products. In the cement industry, this dynamic leads firms to protect standards and codes that require the use of Portland cement; to block or water down state legislation that incentivizes lower-carbon cements and concretes; and to claim, falsely, that clinker substitutes or carbon-sequestering cements are prohibitively expensive to manufacture.

New market entrants are focused predominately on novel cements and concretes; there is little incentive for non-novel cement companies to enter the market. While several novel cement and concrete startups have commercialized their technologies, few have expanded beyond demonstration projects. Prescriptive standards, outdated or restrictive procurement criteria, and cozy industry relationships make it difficult for startups to receive significant procurement contracts or government grants.

In the absence of public policy creating a market for low-carbon cements, smaller competitors are increasingly relying on investment from dominant cement firms, Big Tech, and Big Oil. Amazon and Microsoft in particular have made significant recent investments in novel cement companies. While these investments are providing new pathways to commercialization, they could also consolidate important technology among a handful of powerful monopolies that, without policy intervention, would be well positioned to control the future low-carbon cement and concrete market.

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GREENWASHING

Incumbents are greenwashing their products without emission reductions and consolidating intellectual property without commercializing it.

Dominant firms do not oppose decarbonization outright. Recognizing the appeal of climate-friendly products, incumbents are increasingly announcing pilots, acquisitions, and research that suggest a commitment to reducing carbon emissions. Lafarge invested in Solidia, Heidelberg has invested in carbon capture, and Cemex is marketing its new clinker-substitute cement, Vertua. But these investments are not significantly moving or shaping the market. Nor are they new. Incumbents have repeatedly announced low-carbon cement trials over the last decade but have rarely marketed, commercialized, or expanded commercialization of the resulting products:

- Lafarge has partnered with Solidia since 2013.[34] The companies launched a successful trial project together in 2014, sequestering carbon to cure concrete at Lafarge's Whitehall cement plant, and Lafarge joined Solidia's board at the end of that year.[35] Lafarge then obtained the rights to commercialize Solidia's products in 2015.[36] But it took four years for the companies to announce their first commercial customer, a paver plant in New Jersey.[37] And they have announced no other sales since—even as Lafarge extended its commercialization rights until at least 2025.[38] Instead, Lafarge has announced a number of demonstration pilots—and published a number of press releases trumpeting its ambitions to "reduce CO2 across its value chain" using Solidia's technology.[39]

- Prior to its partnership with Solidia, Lafarge developed its own clinker substitute, a product called Aether. At the time, Lafarge declared that "Aether® cements offer similar properties to ordinary Portland Cement and can be produced in traditional cement plants after minor process adjustments, for a lower overall environmental footprint."[40] But Aether was merely a demonstration project, executed with European Commission funding. Though it was successful—according to an EU database, Aether demonstrated the feasibility of reducing CO2 emissions by up to 30 percent—the resulting cements were not commercialized.[41]

34 Press Release, Lafarge and Solidia Commercialize a New Low-Carbon Solution for the Construction Sector, Lafarge (Apr. 28, 2015), https://www.businesswire.com/news/home/20150428005153/en/Lafarge-and-Solidia-Commercialize-a-New-Low-Carbon-Solution-for-the-Construction-Sector.

35 Id.

36 Id.

37 Press Release, LafargeHolcim and Solidia Technologies Announce First US Commercial Expansion, Lafarge (Aug. 8, 2019), https://www.businesswire.com/news/home/20190808005453/en/LafargeHolcim-and-Solidia-Technologies-Announce-First-US-Commercial-Expansion.

38 Press Release, LafargeHolcim Ramps Up Partnership With Solidia Technologies To Capture CO2 In Building Materials, Lafarge (May 20, 2020), https://www.lafargeholcim.com/lafargeholcim-partnership-solidia-technologies-capture-CO2-building-materials.

36 Id.

40 Press Release, Successful Trial for New General Low Carbon Cement, Lafarge (Jan. 16, 2013), https://www.lafargeholcim.com/sites/default/files/import/press_release/01162013-press_low_carbon_cement_Aether-uk.pdf.

41 Demonstration of the Reduction of CO2 Emissions from the Production of an Innovative Class of Cements, European Commission LIFE Public Database, LIFE09 ENV/FR/000595, https://webgate.ec.europa.eu/life/publicWebsite/project/details/3169.

- Heidelberg has celebrated its investments in carbon capture and sequestration technology. These investments have primarily come through the Low Emissions Intensity Lime And Cement consortium, or LEILAC, a European Union research effort.[42] LEILAC is a pilot project, the first stage of which took five years, and which resulted in another demonstration installation. There is no evidence that Heidelberg is investing in carbon capture at scale, or that it will make other investments in the technology until after its LEILAC research concludes in 2025.[43]

  CRH plc's subsidiary Tarmac is also a participant in LEILAC.[44]

- Cemex recently announced a "net-zero" concrete, Vertua, which it claims is an "industry first"—even though Cemex is purchasing offsets to meet that mark.[45] Vertua is a clinker-substitute novel cement, with an alkali-activated alumina-silicate polymer matrix to replace limestone without generating carbon when heated. Cemex has praised the product for reducing cracking and producing better consistency, and is marketing it in California, where demand for low-carbon concretes is relatively high.[46] But Cemex's framing of the announcement, which cautioned that Vertua is exotic and expensive, raises questions about the extent to which, and how quickly, Cemex plans to deploy it elsewhere.[47]

- Cemex's venture capital arm, Cemex Ventures, invests in "innovative" construction startups.[48] Cemex Ventures hosts an annual Construction Startup Competition to keep tabs on potential competitors or complementary business models. Cemex Ventures leads investment in companies selected through the competition. In 2020, Cemex Ventures chose CarbiCrete as a Top 50 ConTech Startup, eligible for Cemex investment.[49]

These announcements garner praise in the media and from regulators. They also attract investment: Solidia just announced $78 million raised through its last funding round.[50] But dominant cement firms' "climate" investments will produce little in the way of benefits

42 See supra note 23; Low Emissions Intensity Lime & Cement – LEILAC (accessed Jun. 21, 2021), https://www.project-leilac.eu/.

43 Id.

44 Visvesh Sridharan, Future of Cement: Low-Carbon Technologies and Sustainable Alternatives, Sustainalytics (May 18, 2020), https://www.sustainalytics.com/esg-research/resource/investors-esg-blog/future-of-cement-low-carbon-technologies-and-sustainable-alternatives.

45 Cemex, Vertua: Net-Zero CO2 Concrete (accessed Jun. 22, 2021), https://www.cemex.com/sustainability/climate-action/vertua-net-zero-carbon-concrete.

46 Id.; Cemex, Vertua: Available Now in California (accessed Jun. 22, 2021), https://www.cemexusa.com/vertua.

47 Craig Bettenhausen, Cemex Goes Global With Carbon-Neutral Concrete, Chemical & Engineering News, Volume 98, Issue 42 (Oct. 29, 2020), https://cen.acs.org/materials/Chemex-goes-global-carbon-neutral/98/i42.

48 Cemex Ventures, About Us (accessed Jun. 22, 2021), https://www.cemexventures.com/about-us/#our-offer.

49 Press Release, CEMEX Ventures Launch the 50 Most Promising Startups in the 2020 Construction Ecosystem and the Cities of the Future, Cemex (Dec. 14, 2020), https://www.cemex.com/-/cemex-ventures-launch-the-50-most-promising-startups-in-the-2020-construction-ecosystem-and-the-cities-of-the-future.

50 Press Release, Solidia Technologies Closes $78 Million Fundraise and Names Bryan Kalbfleisch CEO, Solidia (Apr. 29, 2021), https://www.csrwire.com/press_releases/721866-solidia-technologies-closes-78-million-fundraise-and-names-bryan-kalbfleisch.

unless they are deployed at scale. And there is sparse evidence incumbents intend to do so. Incumbents' investments are channeled primarily through pilot and demonstration projects, a tactic that further delays commercialization: firms like Heidelberg and Lafarge have repeatedly recommended or invested in additional pilots instead of marketing successful products. Nor are firms like Solidia and Lafarge transparent about the specifications of their products, further limiting commercial uptake.

Incumbents' investment strategies also raise concerns that dominant firms are seeking to block deployment by acquiring smaller and more innovative competitors. Incumbents have amassed cement and concrete tech over the past decade not just through innovation but also through buying it—by investing in firms like Solidia and CarbiCrete, investing in smaller firms through demonstration projects,[51] and "invest[ing] in particular in studies into innovative techniques for the capture and utilisation of CO2."[52] Beyond creating the appearance of innovation, these investments concentrate patent ownership, potentially leading to blockage and monopolistic behavior.[53] Just ten organizations and corporations own 20 percent of all clinker substitution and replacement patents, and they have a natural incentive to keep the market as is: reliant on the Portland cement they already produce at scale.[54] The fact that dominant firms like Lafarge and Heidelberg are "not deriving significant monetary or strategic advantage" from their patents further suggests that incumbents are seeking to keep low-carbon products off the market and on the shelf.[55]

The fact that dominant firms like Lafarge and Heidelberg are "not deriving significant monetary or strategic advantage" from their patents further suggests that incumbents are seeking to keep low-carbon products off the market and on the shelf.

51 Press Release, Svante, LafargeHolcim, Oxy Low Carbon Ventures And Total Launch Study For Commercial-Scale Carbon Capture And End-Use At U.S. Plant, Holcim (Jan. 6, 2020), https://www.holcim.com/joint-carbon-capture-project-usa-plant.

52 Energy and Climate Protection, HeidelbergCement (accessed Jun. 22, 2021), https://www.heidelbergcement.com/en/energy-and-climate-protection.

53 Lehne and Preston, supra note 11, at 33. Most of the remaining organizations are based in China.

54 Id. at 28, 33. Most of the remaining organizations are based in China.

55 Id. at 29.

PRESCRIPTIVE STANDARDS & PROCUREMENT

Standardization and compliance are crucial in the construction industry due to high degrees of safety concerns and liability. To be accepted as an industry standard product, inputs (including cement and cement alternatives) must receive evaluation reports from the International Code Council (ICC), comply with standards organizations such as the American Society for Testing and Materials (ASTM), and meet building code requirements. This process can take many years, and it can take several decades for the industry to accept that durability has been properly evaluated by testing regimes.

Cement standards have traditionally been prescriptive, specifying methods of construction and imposing restrictions on the compositional parameters of concrete mix.[56] This can prevent the uptake of new materials and engineering design methods and preclude local flexibility. It is also unwarranted: although safety is a paramount concern, for the majority of applications it is unnecessary to require that novel products exhibit specific characteristics similar to Portland cement. The novel cements that are already commercializing at a small scale have met Portland cement standards, but to allow for widespread adoption and competition, this expectation should not persist. Even with strength specifications remaining the same, expanding chemical and physical standards would allow for more innovation and competition without forgoing safety. As it stands, by allowing companies to compete only on price rather than on service or product, prescriptive standards also benefit incumbents.[57] And though standards are voluntary, in that they are developed through consensus by third parties that cannot require their use, they nevertheless have widespread legal effect: standards are referenced by federal, state, and local regulations; incorporated into building codes; and used in binding construction contracts.[58]

As it stands, by allowing companies to compete only on price rather than on service or product, prescriptive standards also benefit incumbents.

Moreover, once cement alternatives meet all regulations, standards, and codes, they must be adopted. And due to inflexible industry standards and construction liability, implementation has been stagnant. In practice, engineers review industry guidelines and have a set of standard specifications to apply.[59] Almost all structural engineers are responsible for the review and

56 CarbonCure, Concrete Expert Dr. Michael Thomas Makes the Case for Performance-Based Specs (accessed Jun. 9, 2021), https://www.carboncure.com/concrete-corner/concrete-expert-dr-michael-thomas-makes-the-case-for-performance-based-specs/.

57 Lehne and Preston, supra note 11, at 47-53.

58 ASTM, Frequently Asked Questions (accessed Jun. 9, 2021), https://www.astm.org/FAQ/.

59 "Ensuring Quality Concrete," Structure Magazine (Jun. 2016), https://www.structuremag.org/?p=10052; https://dot.ca.gov/programs/construction/construction-manual/section-4-90-concrete.

evaluation of mix designs for the project, while the cement plant and contractors are responsible for ensuring the cement and concrete mix meets state and local building codes.[60] Variables, including site conditions, climate, and geography, leave room for liability and error, which puts contractors' and engineers' licenses on the line.

To address this bottleneck, guidelines, education, and training need to be updated. Many structural engineers do not consider low-carbon concrete and cement alternatives as viable commercial options, despite successful cases in places like Hawaii and California, which is explained further in the Recommendations section. This is partially because there is little familiarity, but also because many alternatives are not suited to all types of construction projects, making the educational component even more important.[61] Without a clear understanding of which low-carbon cements are best suited for various construction applications, there is a strong incentive to continue using Portland cement.

The best way to ensure that dominant firms do not win all procurement contracts is to create a healthier and more competitive cement market.

Public procurement offices are similarly unequipped. Most lack the incentive to purchase low-carbon cements and concrete; many are unfamiliar with the products. The regionally consolidated nature of the cement industry also means that procurement officers have built relationships with regional firms over time. Moreover, the absence of smaller competitors means that there is often only one or two firms vying for public procurement contracts. The best way to ensure that dominant firms do not win all procurement contracts is to create a healthier and more competitive cement market.

The concentrated power of dominant firms must also be addressed. A handful of major producers disproportionately shape the standardization process: they are well represented in industry associations and have greater resources for interacting with standards committees and procurement bodies than smaller firms do.[62]

60 Id.

61 Alternative Materials Could Shrink Concrete's Giant Carbon Footprint, Chemical & Engineering News, Volume 98, Issue 45 (Nov. 22, 2020), https://cen.acs.org/materials/inorganic-chemistry/Alternative-materials-shrink-concretes-giant/98/i45.

62 Green Public Procurement for Natural Gas, Cement, and Steel, Resources for the Future (Nov. 2020), https://www.rff.org/publications/reports/green-public-procurement-natural-gas-cement-and-steel/.

LOBBYING & INFLUENCE

Incumbents have an outsized voice in industry associations and technical committees.

Dominant cement corporations use their wealth and market power to shape federal, state, and local industrial policy. They influence all aspects of cement and concrete regulation, policy, and science. They are well represented on the ASTM and ACI committees that establish standards and code requirements. They control the powerful industry associations that lobby lawmakers and policymakers to both weaken climate laws and to entrench prescriptive standards favoring Portland cement. And they fund the academic research that shapes policymakers' understanding of cement, concrete, and infrastructure science.

For example:

- The Portland Cement Association (PCA) promotes Portland cement through lobbying, influence campaigns, and investments in research. It is led almost exclusively by dominant cement corporations. The PCA's chairman was previously the president of Boral Construction Materials, a major Australian construction materials firm whose North American operations were recently acquired by the petrochemical and building-material manufacturer Westlake.[63] Its vice chairman is the president and CEO of Votorantim Cimentos North America, a branch of the seventh-largest cement corporation in the world.[64] Ten other multinational corporations control thirty out of forty director seats on the PCA's board, either directly or through their subsidiaries. The remainder of seats are predominantly held by global cement firms.[65]

- The ASTM Cement Committee develops and maintains cement standards. It, too, is closely intertwined with industry. The committee's vice chair is a vice president of St. Mary's Cement, a Votorantim Cimentos subsidiary. Five of the eleven remaining committee positions are held by representatives from large cement corporations, including firms owned by LafargeHolcim, CRH, GCC, and Grupo Argos.[66]

- The MIT Concrete Sustainability Hub, or CSHub, is a leading research team working to improve cement and concrete's sustainability. CSHub was founded by the Portland Cement Association and Ready Mix Concrete Research & Education Foundation and continues to receive funding from the two associations.[67]

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63 Portland Cement Association, Leadership (accessed Jun. 9, 2021), https://www.cement.org/about/leadership; Press Release, Boral Agrees to Sell Its North American Building Products Business, Boral (Jun. 21, 2021), https://cdn-api.markitdigital.com/apiman-gateway/ASX/asx-research/1.0/file/2924-02386227-2A1304322?access_token=83ff96335c2d45a094df02a206a39ff4.

64 Press Release, Votorantim Cimentos Ends 2020 With Global Net Revenue of R$16.7 Billion, an Increase of 29% Compared to 2019, Votorantim Cimentos (Apr. 8, 2021), http://www.votorantimcimentos.com/en-US/media-center/news/Pages/Votorantim-Cimentos-2020-Results.aspx.

65 Portland Cement Association, supra note 63.

66 Committee C01 on Cement, ASTM International (accessed Jun. 9, 2021), https://www.astm.org/COMMIT/OFFICERS/C01.htm.materials/inorganic-chemistry/Alternative-materials-shrink-concretes-giant/98/i45.

67 Green Public Procurement for Natural Gas, Cement, and Steel, Resources for the Future (Nov. 2020), https://www.rff.org/publications/reports/green-public-procurement-natural-gas-cement-and-steel/.

Dominant firms use their influence to shape policy at every level of government. Recent, prominent examples exist at the state level, where industry associations successfully lobbied to weaken state legislation to address cement and concrete emissions:

- **New York – watered down procurement legislation.** In New York, the state legislature recently passed the Low Embodied Carbon Concrete Leadership Act (LECCLA), legislation aimed at incentivizing public procurement of low-carbon cements and concretes. Model LECCLA legislation was first introduced in the state, requiring all state agencies and departments to factor climate impact in their selection criteria for concrete procurement, applying a discount rate to the price of bids incorporating low-embodied carbon concretes.[68] But the Associated General Contractors of New York State and other industry groups fiercely opposed it. They argued without evidence that if the state didn't test low-carbon concrete products first, their use "could have significant impact to the quality of our public facilities," leading to "catastrophic results" and resulting in "significant cost increases."[69] As a result, lawmakers stripped incentives from the Act and delayed its implementation. The final bill instead directs the Office of General Services to establish guidelines for procuring low-carbon concrete within a year.

  While still promising, the legislation now awaiting Governor Hochul's signature is significantly less ambitious than the one sponsors first envisioned.[70] The amended Act no longer requires the state to use competitive bidding to reduce carbon intensity, but only directs it to consider doing so; the timeline for implementation was also extended. More importantly, the amended Act empowers incumbents to block or water down any future low-embodied carbon concrete guidelines.[71] Rather than establishing new procurement criteria by statute, the amended Act defers to the Office of General Services to write them. And it requires the Office to confer with industry as part of that process, including "any relevant associations that set industry standards," "affected contractors and subcontractors," and "representatives of the construction industry."[72] Giving industry such significant control over the creation of standards will inevitably weaken them.

68 Portland Cement Association, Leadership (accessed Jun. 9, 2021), https://www.cement.org/about/leadership; Press Release, Boral Agrees to Sell Its North American Building Products Business, Boral (Jun. 21, 2021), https://cdn-api.markitdigital.com/apiman-gateway/ASX/asx-research/1.0/file/2924-02386227-2A1304322?access_token=83ff96335c2d45a094df02a206a39ff4.

69 Press Release, Votorantim Cimentos Ends 2020 With Global Net Revenue of R$16.7 Billion, an Increase of 29% Compared to 2019, Votorantim Cimentos (Apr. 8, 2021), http://www.votorantimcimentos.com/en-US/media-center/news/Pages/Votorantim-Cimentos-2020-Results.aspx.

70 Portland Cement Association, supra note 63.

71 Assembly Bill A2591A, The New York State Low Embodied Carbon Concrete Leadership Act, Amendment A, 2020-2021 Legislative Session, https://www.nysenate.gov/legislation/bills/2021/a2591/amendment/a.

72 Id.

- **California – cement removed from Buy Clean.** California enacted a Buy Clean law in 2017 to require state agencies to consider the carbon cost of building materials. Upon pressure from industry, however, cement and concrete were removed from the Buy Clean legislation before passage. Cement manufacturing is the state's second-largest industrial source of carbon pollution, and cement was included in an earlier version of the bill.[73] But the Act's lead sponsor, then-Assembly Member Rob Bonta (D-Alameda), said the cement and concrete industries demonstrated "significant opposition," as did Caltrans, which claimed that requiring the carbon cost of cement and concrete would significantly increase its costs.[74] Concrete trade associations also said they were unprepared to provide the environmental product declarations required to demonstrate compliance.[75] These claims were disputed, including by U.S. Concrete, which supported the Act.[76] And they are belied by California's current cement and concrete market, where there is significant demand for low-carbon concrete mixes.

Photo credit: Wil Stewart

73 Alex Jackson, California Senate Passes Bill to Slash Cement Emissions, NRDC Expert Blog (Jun. 17, 2021), https://www.nrdc.org/experts/alex-jackson/california-senate-passes-bill-slash-cement-emissions; Does California's "Buy Clean Act" Favor Steel & Mineral Wool?, SBC Magazine, originally published by Code Watcher (Oct. 30, 2017), https://sbcmag.info/news/2017/nov/does-californias-buy-clean-act-favor-steel-mineral-wool.

74 Id.

75 Paula Melton, Concrete Pours Through Loophole in New Carbon Law, Building Green (Jan. 11, 2018), https://www.buildinggreen.com/news-analysis/concrete-pours-through-loophole-new-carbon-law.

76 SBC Magazine, supra note 73.

BIG TECH & BIG OIL

Tech and energy monopolies are emerging as the only path to commercialization for independent startups.

As noted above, a number of novel cement and concrete companies have entered the U.S. market in recent years. Most have received notable capital investment either from legacy cement firms, dominant technology corporations, multinational energy monopolies, or a combination of the three:

Startup	Funding Raised	Investors	Board Members	Partnerships/Investors of Concern
Svante	> $195M	• Chevron Tecnology Ventures • OGCI Climate Investments • Temasek	• CEO, OGCI Climate Investments	Collaboration agreement with Total S.A. & Lafarge in 2018. And in 2020, launched a commercial-scale carbon capture study at a Lafarge plant, with Lafarge, OLCV (subsidiary of Occidental) & Total
SOLIDIA	> $100M	• Breakthrough Energy Ventures (BEV) • LafargeHolcim • OGCI Climate Investments	• Ventures Director, OGCI Climate Investments • Head of Growth, LafargeHolcim • OGCI Climate Investments	Entered an agreement with Lafarge in 2013 (and lasting until 2025 with option to extend), allowing them to commercialize Solidia's technology
CARBON CURE	> $18M	• Amazon's Climate Pledge Fund • Breakthrough Energy Ventures (BEV) • Microsoft Innovation Fund • NRG COSIA Carbon XPrize • OGCI Climate Investments	• Member, Breakthrough Energy Ventures (BEV)	Strategic partners include Breakthrough Energy, Amazon, Microsoft, Mitsubishi, Carbon Direct, Stripe, Shopify, BDC, Linde, Elemental Excelerator, and World Alliance for Efficient Solutions by the Solar Impulse Foundation
ecocem	> $26.5M	• Breakthrough Energy Ventures (BEV) • Dermot Desmond • Saint-Gobain	• Member, Breakthrough Energy Ventures (BEV)	BEV invested in Ecocem in May 2021, but Ecocem is currently operating almost entirely abroad (U.S. subsidiary is Orcem Americas, with no apparent production)
CarbonBuilt	> $7.5M	• NRG Cosia Carbon XPrize • Stripe • UCLAk	• No Public Board	Appear conflict free based on publicly reported investor partners
CarbiCrete	> $10M	• Harsco • Québec gov- Technoclimat Program • SQN Ventures LLC • Sustainable Development • Technology Canada (SDTC)	• No Public Board	Harsco's Environmental division is the largest & most comprehensive provider of onsite material processing and environmental services to the metals industry, with operations at >130 customer sites across 32+ countries
Blue Planet	> $10M	• Chevron Tech Ventures • Leonardo DiCaprio • Mitsubishi Corp. • Knife River Corp.	• David C. Barney, CEO of Knife River Corp.	Knife River Corp. - One of the largest construction materials & contracting companies in the U.S.

Technology corporations are especially intertwined with low-carbon cement and concrete companies, investing in almost every startup and taking seats on their boards:

- One of the biggest players in low-carbon cement technology and policy is Breakthrough Energy Ventures (BEV). BEV was founded in 2015 by Bill Gates with amorphous goals but significant investment, and the involvement of a bevy of billionaires—from Jeff Bezos and Michael Bloomberg to Richard Branson and Jack Ma. The coalition has in many ways become the leader in low-carbon cement investing. BEV's $2 billion fund has invested in almost every major low-carbon cement startup and sits on the board of several, including CarbonCure and EcoCem.[77]

- Amazon's Climate Pledge Fund has also made significant investments in low-carbon cements and concretes. Amazon launched the venture capital fund in 2020 with $2 billion to invest in companies endeavoring to decarbonize building and industrial materials, among others. The Climate Pledge Fund has invested in CarbonCure, a small, commercialization-focused firm that retrofits concrete plants to embed carbon dioxide into fresh concrete as it is mixed.[78]

- In addition to his involvement with BEV and Amazon's Climate Pledge Fund, Jeff Bezos has promised to spend $10 billion fighting climate change through his Earth Fund.[79] The Earth Fund's goals remain obscure, but Bezos's initial $791 million investment included funding to help expand the global market for climate-safe cement.[80]

- Similarly, Microsoft launched its Climate Innovation Fund in 2020, promising to invest $1 billion. The goal of the fund is to accelerate development of carbon reduction, capture, and removal technologies, an effort the company undertook in concert with a commitment to make Microsoft climate-negative by 2030.[81] The two goals are complementary, with investments in the fund working to decarbonize Microsoft's own supply chain and providing vehicles, eventually, for Microsoft to remove carbon from the atmosphere in order to meet its emissions goals. The Climate Innovation Fund also invested in CarbonCure in 2020.[82]

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77 Amazon and Breakthrough Energy Ventures Co-Lead Investment in Cleantech Company, CarbonCure, BusinessWire (Sept. 17, 2020), https://www.businesswire.com/news/home/20200917005545/en/Amazon-and-Breakthrough-Energy-Ventures-Co-Lead-Investment-in-Cleantech-Company-CarbonCure; Press Release, Ecocem Materials Limited Raises €22.5m from Breakthrough Energy Ventures and Breakthrough Energy Ventures Europe, EcoCem (May 6, 2021), https://www.ecocem.ie/ecocem-materials-limited-raises-e22-5m-from-breakthrough-energy-ventures-and-breakthrough-energy-ventures-europe/.php/2020/10/24/carboncure-solidifies-ties-to-amazonand-microsoft-founders-climate-funds/.

78 Amazon, The Climate Pledge Fund (accessed Jun. 22, 2021), https://sustainability.aboutamazon.com/about/the-climate-pledge/the-climate-pledge-fund.

79 Theodore Schleifer, Jeff Bezos Will Spend $1 Billion a Year to Fight Climate Change, Recode (Mar. 9, 2021), https://www.vox.com/recode/22321861/jeff-bezos-climate-earth-fund-andrew-steel-amazon.

80 Press Release, Gift Targets Large-Scale Emissions Reductions in Transportation and Industrial Sectors, ClimateWorks (Nov. 16, 2021), https://www.climateworks.org/press-release/bezos-earth-fund-grants-50-million-to-climateworks-foundation/; Annie Palmer, Jeff Bezos Names First Recipients of His $10 Billion Earth Fund For Combating Climate Change, CNBC (Nov. 16, 2020), https://www.cnbc.com/2020/11/16/jeff-bezos-names-first-recipients-of-his-10-billion-earth-fund.html.

81 Brad Smith, Microsoft Will Be Carbon Negative by 2030, Microsoft Blog (Jan. 16, 2020), https://blogs.microsoft.com/blog/2020/01/16/microsoft-will-be-carbon-negative-by-2030/.

82 CarbonCure Solidifies Ties to Amazon and Microsoft Founders, Climate Funds, Concrete News (Oct. 24, 2020), http://concreteproducts.com/index.php/2020/10/24/carboncure-solidifies-ties-to-amazonand-microsoft-founders-climate-funds/.

Fossil fuel corporations are similarly invested in low-carbon cement and concrete, whether to vertically integrate cleaner cement into their business models or simply to deploy capital:

- The Oil and Gas Climate Initiative (OGCI) was established by the largest fossil fuel corporations in 2014. A $1 billion fund, OGCI has invested in Solidia as part of its efforts to decarbonize industry and its own supply chain.[83]

- Total Energy Ventures (TEV) is the venture capital arm of the French oil and gas giant Total. It too has invested in Solidia, as part of a "win-win" investment strategy to "co-build" solutions for Total's difficult problems.[84] "By fostering relationships between the Group's various entities and this very dynamic ecosystem," said TEV's investment head following the Solidia capitalization, "we are an innovation driver for Total." TEV further explained that the "whole issue of capture, storing and use of CO2 is a major challenge for the group," and that it saw Solidia as potential means for increasing CO2 demand, which Total could in turn supply.[85]

The scope of investment from Big Tech and Big Oil monopolies also deserves special attention from regulators due to the consolidated power of the investor base.

- BP has also invested in Solidia as part of its venture business, in a portfolio of investments made to find "smarter ways" of running its own business. "This approach gives us faster, cheaper access to ideas and technologies than if we tried ourselves," BP's head of business development said.[86]

- Halliburton Energy Services launched Halliburton Labs in 2020, with the goal of expanding sustainability services to its customers and reducing industry emissions. Halliburton Labs invests in early-stage companies, including those developing carbon capture and storage and cement technologies.[87] Halliburton Energy Services is the third-largest holder of clinker substitution and replacement patents.[88]

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83 OGCI, About Us (accessed Jun. 16, 2021), https://www.ogci.com/about-us/; https://www.ogci.com/ogci-announces-three-investments-low-emissions-technologies-launches-third-annual-report/.

84 Press Release, Total Energy Ventures Invests in Solidia Technologies, Total Energies (Sept. 14, 2014), https://totalenergies.com/media/news/press-releases/total-energy-ventures-invests-solidia-technologies; Total Energies, Advertorial, Total Energy Ventures Invests in the Future, CNBC (Nov. 25, 2020), https://www.cnbc.com/advertorial/2016/04/13/total-energy-ventures-invests-in-the-future.html.

85 Id.

86 Press Release, Venturing Into the Future: How BP is Developing Next Generation Technologies, BP (May 17, 2017), https://www.bp.com/en/global/corporate/news-and-insights/reimagining-energy/bp-venturing-fulcrum-peloton-solidia.html.

87 Halliburton, Sustainable Energy Solutions (accessed Jun. 22, 2021), https://asr.halliburton.com/environment/sustainable-energy-innovations/.

88 Lehne and Preston, supra note 11, at 28.

Investments from technology and oil companies provide needed capital for cement and concrete startups. One startup that has received substantial technology investment described its partnership with Big Tech as its only pathway to commercialization unless procurement decisions and standards change. But the scope of investment from Big Tech and Big Oil monopolies also deserves special attention from regulators due to the consolidated power of the investor base. Further vertical integration must be prevented as part of a broader strategy to build healthier, more competitive cement and concrete markets.

The concentrated investor base raises additional concerns about the consolidation of intellectual property in the hands of dominant firms. Both Solidia and Halliburton are top cement patent assignees, and the oil and gas companies invested in the former have made clear that they wish to use demonstrated technologies in their own supply chain.[89] That could be a good thing for emissions reductions but must not serve to delay commercialization and deployment across the broader cement and concrete industries.

In the technology sector, the ecosystem monopolistic firms are building around cement and concrete startups deserves similar scrutiny. Amazon is both a technology and an infrastructure company, and it competes aggressively for government contracts. It is not difficult to imagine Amazon's investments as the first step toward a broader industrial-materials play—one that, at very least, could leave critical emission-reduction technology in the hands of an economy-spanning conglomerate that regularly uses its control of supply chains to foreclose competition in other industry segments. This could create a barrier to entry, whereby Amazon becomes the only entity capable of sourcing the low-carbon cement or concrete required by future policy or procurement standards. Amazon's investments in advocacy supporting its own cement portfolio companies reinforce these concerns.[90]

III. POLICY SOLUTIONS & RECOMMENDATIONS

There is no one technological solution for decarbonizing cement and concrete. Portland clinker reduction, novel low-carbon cements, and carbon sequestration must likely all be deployed to achieve meaningful carbon reductions. Moreover, their feasibility will vary by state and locality. Whether other materials may be substituted for clinker, for example, depends in turn whether

89 Id. Halliburton and Solidia are top assignees for patents related to clinker substitution and replacement, e.g., technologies yet to be commercialized at great scale.

90 Amazon has, for example, invested in CarbonCure and procured its technology, while also investing in policy and advocacy that will promote CarbonCure's technology. See Palmer, supra note 80; Amazon HQ2 Case Study, CarbonCure, https://go.carboncure.com/rs/328-NGP-286/images/CC_OP-MillerandLong-AmazonHQ2.pdf.

and what industrial waste is accessible locally; transporting inputs from other states or nations can generate significant emissions, and the availability of common substitutes like fly ash and blast furnace slag is declining in many areas. Nor should the federal government mandate the use of specific cement formulas or ingredients.

Transitioning to low-carbon cements therefore requires a two-pronged public policy approach. First, policymakers must create demand for low-carbon products by requiring federal, state, and local procurement officials and engineers to move to cleaner cement and concrete. Standard-setting bodies should also be made to update and move to performance-based standards, and customers pushed to use them. The goal should be to create a diversified cement and concrete supply chain, without choosing technological winners and losers.

Second, government enforcers and regulators should scrutinize the cement and concrete industries and take action when necessary to keep them competitive. The consolidated firms that control the industry should be prevented from blocking entry of new firms through standard-setting or killer acquisitions. Technology and energy monopolists must similarly be prevented from consolidating low-carbon intellectual property in ways that prevent its deployment outside their own vertically integrated supply chain.

Together, these two policy strategies will build a stronger and more competitive cement and concrete market, where independent companies and market entrants selling lower-carbon products can compete and thrive.

PROCUREMENT

Procurement is the most important strategy for building a healthier, more competitive, and lower-carbon cement and concrete market. Public procurement decisions shape the cement and concrete market, driving manufacturing decisions and investment in lower-carbon cement technologies. By adopting procurement policies that favor low-carbon and high-blend cements, state and local governments can encourage more cement startups to enter the market and create demand for their products. They can also provide market entrants with a pathway to commercialization: purchasing or preferencing low-carbon cements and concretes will send a strong signal to the market, forcing dominant firms to commercialize high-blend and novel cements at scale and creating opportunities for new market entrants to compete.

States and local governments should commit to purchasing lower-carbon cements and concretes, incorporate embodied carbon metrics into their procurement processes, and set carbon-intensity targets for major projects, including by making building permits contingent on demonstrating lower-embodied carbon.[91] Promising models exist at the state level:

- **Procurement guarantees.** The most important thing state and local governments can do to build a market for low-carbon cements and concretes is to communicate to suppliers that they will procure low-carbon cements. The Hawaii state DOT, for example, committed in 2019 to using carbon-injected concrete in future construction projects, including a planned freeway interchange.[92] The announcement followed a City of Honolulu resolution committing the city to consider carbon dioxide-mineralized concrete for use in all city and county capital improvement projects.[93] Together, these announcements guaranteed a market for low-carbon cement and concrete in the state. The state legislature has also advanced legislation that would require all state building construction to use carbon-mineralized concrete unless doing so would increase costs or delay construction.[94] Although initial statistics on adoption have been difficult to verify, a low-carbon cement founder confirmed that the policy has guaranteed demand.

Procurement is the most important strategy for building a healthier, more competitive, and lower-carbon cement and concrete market.

- **Buy Clean.** As noted above, California's Buy Clean Act requires that state agencies consider the carbon cost of building materials.[95] In order for products to be eligible for state purchase, the emissions produced by their manufacture must fall below a state benchmark, benefiting low-carbon suppliers. However, the program does not yet cover cement or concrete and does not encourage further carbon reductions beyond state benchmarks, and carbon-content data reliability and availability remain limited.[96] Other states and the federal government should consider establishing bolder Buy Clean policies inclusive of cement and concrete.

91 Id. at 91.

92 Sebastien Malo, U.S. Lawmakers Take a Concrete Step to Battle Emissions, Reuters (Jul. 2, 2019), https://www.reuters.com/article/us-climate-change-usa-carboncapture/u-s-lawmakers-take-a-concrete-step-to-battle-emissions-idUSKCN1TX1KB.

93 Katarina P. Matayoshi, Greening the Concrete Jungle, Hawaii Business (Sept. 9, 2019), https://www.hawaiibusiness.com/greening-the-concrete-jungle/.

94 H.D. 1282, Relating to State Building Construction, 2019, https://www.capitol.hawaii.gov/Archives/measure_indiv_Archives.aspx?billtype=HB&billnumber=1282&year=2019.

95 Buy Clean California Act, California Department of General Services (accessed Apr. 14, 2021), https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act.

96 Ed Rightor et al., 'Buy Clean' policies have promise, but we first need to know which products are low-carbon, American Council for an Energy-Efficient Economy (Dec. 21, 2020), https://www.aceee.org/blog-post/2020/12/buy-clean-policies-have-promise-we-first-need-know-which-products-are-low-carbon.

- **LECCLA.** The model Low Embodied Carbon Concrete Leadership Act provides a model for states to follow to encourage the procurement of lower-carbon products. This model version would require all state agencies and departments to factor climate impact in their selection criteria for concrete procurement, applying a discount rate to the price of bids incorporating low-embodied carbon concretes.[97] As discussed above, the New York state legislature weakened the model legislation, removing the discount rate requirement and leaving procurement changes to the discretion of a state agency, which must consult with industry. The New Jersey version of the bill is stronger because it directs the state to implement such a discount rate directly through the legislation.[98] Legislators in other states are also considering LECCLA legislation.

  The model LECCLA legislation could be strengthened. LECCLA does not require the state to use low-embodied carbon concretes. Good data is also needed for the legislation to be effective. Like other low-carbon concrete procurement programs, LECCLA uses environmental product declarations (EPD) to capture total embodied emissions; while well established, EPDs can be improved.[99]

  But LECCLA is promising for several reasons. First, it is technology neutral, embracing both novel cements and clinker substitutes, including nontraditional substitutes. Second, LECCLAs appear to have the potential to garner widespread support, despite New York's example. Both the labor and environmental industries support the LECCLA legislation in New Jersey, a marked accomplishment. So, too, do low-embodied carbon startups in the state, which hope that the legislation will grow the market for their products and allow them to compete with bigger players. Finally, the size of the low-carbon emission bid discount, at five percent, is large enough to give competitors an advantage in the bidding process, which they need to meaningfully challenge incumbents.[100]

- **Building local markets.** While small in size, the Village of Hastings-on-Hudson demonstrates the efficacy of grassroots approaches to supporting low-carbon cements and concretes. In May 2020, the village passed a resolution promising to support the use of any kind of low-carbon concrete, whether achieved through reduced cement use, high-blend cements, or local cement production.[101] The resolution is significant for its broadness, as it

97 Open Air Collective, What Is #LECCLA? (accessed Apr. 9, 2021), https://openaircollective.cc/leccla; Assembly Bill A2591, The New York State Low Embodied Carbon Concrete Leadership Act, 2020-2021 Legislative Session, https://www.nysenate.gov/legislation/bills/2021/A2591; Assembly Bill No. 5223, 219th Legislature, introduced Jan. 7, 2021, https://www.njleg.state.nj.us/2020/Bills/A9999/5223_I1.HTM.

98 Matthew P. Adams, Concrete Solutions to Climate Change, Rockefeller Institute of Government (Jun. 2021), https://rockinst.org/wp-content/uploads/2021/06/Concrete-Solutions-to-Climate-Change.pdf.

99 Tech Brief: Environmental Product Declarations, U.S. Department of Transportation, Federal Highway Administration (Jul. 2020), https://www.fhwa.dot.gov/pavement/sustainability/hif19087.pdf; Essentials of the "'Buy Clean California" Act, FGIA News (May 15, 2019), https://fgiaonline.org/news/essentials-of-the-buy-clean-california-act.

100 Sasha Stashwick, Smart Procurement Policies Can Help Decarbonize Concrete, NRDC Blog (Mar. 5, 2021), https://www.nrdc.org/experts/sasha-stashwick/smart-procurement-policies-can-help-decarbonize-concrete.

101 Low-Embodied Carbon Concrete Resources, Village of Hastings-on-Hudson (accessed Apr. 8, 2021), https://www.hastingsgov.org/climate-smart-communities-task-force/pages/low-embodied-carbon-concrete-resources.

provides the village the flexibility to pursue any technological solutions available to them.[102] Additionally, the resolution commits the village to build a local market for low-carbon cement and concretes by promoting them to other towns and local governments. As a result, neighboring towns are already adopting similar resolutions, combining their purchasing power to push state suppliers to manufacture lower-carbon concretes.[103] It is too early to evaluate impact, but the program is a case study to inform future policy implementation at the local level.

Federal agencies can use their administrative authorities to support low-carbon cement and concrete, without waiting on Congress:

- **Agency procurement.** Federal agencies should adopt procurement standards embracing lower-embodied carbon cements. Agencies that purchase large amounts of concrete and cement, like the Department of Defense and General Services Agency, should lead by pledging to purchase low-carbon products. A cross-agency federal procurement policy could be established by executive order or by congressional action. It could either incentivize or require that federal agencies only use high-blend or novel cements, or otherwise reduce the amount of cement they are using. Federal and agency-specific procurement policies would be a logical first step toward building the data and standards-setting capacity necessary to regulate all construction and manufacturing products.

- **Convening power.** The federal government can use its convening power to push state and local governments to coordinate on large-scale infrastructure projects—encouraging them to align low-embodied cement procurement decisions in order to scale demand for these products, and promoting performance-based technical standards.

Finally, Congress can require federal agencies and grantees to procure low-carbon cement and concrete, and incentivize states to do the same:

- **R&D funding.** States are required under federal law to spend two percent of their federal transportation funds on planning and research.[104] This includes researching engineering standards and construction materials for transportation applications. The next federal transportation package should increase state R&D funding and direct states to use a portion

102 Adams, supra note 98, at 12.

103 Id. at 12-13.

104 23 U.S.C. § 505.

of these funds specifically on low-carbon cement evaluation and standards. Sustained R&D investment will lay the necessary groundwork for the broader use of high-blend and novel cements, providing needed funding to new market entrants. Moreover, work done by states to test the durability and performance of high-blend and novel cements can contribute to efforts to develop updated and more iterative product standards and evaluative tools.[105]

- **Grant funding.** The Department of Energy plays an important role in the low-carbon cement and concrete markets through its funding of industrial carbon emission-reduction technology. The Department should continue to advocate to expand its funding, and review and amend award criteria to ensure that it is supporting new market entrants and not further enriching dominant firms.

  Congress greatly expanded federal carbon capture and removal programs in the Energy Act of 2020, authorizing nearly $1.4 billion in funding for related research and development programs for the 2022 fiscal year.[106] This includes $23 million for the Department of Energy's Carbon Utilization Program, which funds projects to develop technologies that mineralize carbon dioxide or transform waste carbon into value-added products.[107] Similar projects are funded through other streams, including the Department's industrial emissions reduction technology development program, which the Energy Act of 2020 also expanded, and through ARPA-E.[108]

  The Biden administration has already proposed to further expand carbon utilization research, development, and commercialization programs in its annual budget proposal. This request was welcomed by cement and concrete startups, which believe that they will be better able to compete for grants if more funding is available. But the Department can do more to ensure that existing and future dollars benefit market entrants. This can be accomplished through award criteria preferencing smaller companies and by ensuring that reporting and financing requirements do not effectively bar smaller firms from competing for grants. Both tactics will require the administration to make good on its commitment to take risks and support clean energy startups—even where there is a risk that a small number of its bets won't pay off.[109]

105 Lehne and Preston, supra note 11, at 54-55.

106 Consolidated Appropriations Act, 2021, §§ 4004, 6003 (summary available at https://www.energy.senate.gov/services/files/32B4E9F4-F13A-44F6-A0CA-E10B3392D47A); Funding for Carbon Capture and Carbon Removal at DOE, Congressional Research Service (Jun. 16, 2021), https://www.everycrsreport.com/files/2021-06-16_IF11861_63658781d4eb1b8a9cbeba84c83c811cad221cbe.pdf.

107 Consolidated Appropriations Act, 2021, §§ 4004, 6003; Carbon Utilization, U.S. Department of Energy, Office of Fossil Energy and Carbon Management (accessed Jun. 12, 2021), https://www.energy.gov/fe/carbon-utilization; David Iaconangelo et al., Biden's Clean Energy Plans: Revolution or Red Tape?, E&E News (Jun. 2, 2021), https://www.eenews.net/stories/1063733965; Press Release, DOE Invests $17 Million to Advance Carbon Utilization Projects, U.S. Department of Energy (Jun. 16, 2020), https://www.energy.gov/articles/doe-invests-17-million-advance-carbon-utilization-projects.

108 Id.

109 Michael Grunwald, Scoop: The Obama Scandal Biden Wants to Bring Back, Politico (Jul. 12, 2021), https://www.politico.com/newsletters/politico-nightly/2021/07/12/scoop-the-obama-scandal-biden-wants-to-bring-back-493541?nname=politico-nightly&nid=00000170-c000-da87-af78-e185fa700000&nrid=0000014e-f110-dd93-ad7f-f91539120002&nlid=2670445.

One way to do this is to focus grants not just on demonstration but on commercialization. While sufficient capital is important, the timeline between testing or prototyping and commercialization is equally so. If federal grant criteria keep startups from reaching commercial markets, they will be incentivized to seek funding from other, potentially conflicted investors. Incentivizing and supporting companies as they scale will allow startups to remain independent from industry incumbent funding as they reach commercialization.

In addition, simply applying for grants and complying with reporting requirements takes significant resources—most notably data and staff time—that only dominant firms have. This helps explain why Cemex has been awarded multiple Department of Energy grants in recent years.[110] Award criteria should be evaluated to minimize competitive advantages for incumbents, and compliance assistance should be provided to smaller firms. Otherwise, barriers to federal funding will leave smaller firms reliant only on the venture capital market or on partnerships with dominant firms.

- **Clean products standard.** Federal policymakers could then investigate whether to adopt a clean products standard (CPS). The standard would establish a maximum amount of greenhouse gases that can be emitted in the production of industrial products sold in the United States.[111] Developing standards and compliance metrics would take significant effort and investment, and its administration would be a challenge; a CPS must not price out smaller competitors by imposing outsized compliance costs. But a CPS could complement federal, state, and local procurement policies, the data from which could be used to assess the cement industry's average climate performance and set mandatory federal emissions thresholds.[112] The Clean Future Act would establish a federal Buy Clean program and a National Environmental Product Declaration Database to support it.[113]

DATA

For novel cements to be adopted at scale, governments and engineers must have access to reliable information regarding their performance and embodied-carbon levels. If data regarding products' durability is not shared, standards embracing these products will not

110 Press Release, CEMEX Awarded Grant From U.S. Department of Energy to Develop Pioneering Carbon Capture Technology, CEMEX (Feb. 8, 2021), https://www.cemex.com/-/cemex-awarded-grant-from-u-s-department-of-energy-to-develop-pioneering-carbon-capture-technology; U.S. Department of Energy, Advanced Manufacturing Office FY20 Multitopic FOA Selections Table, FY 2020, https://www.energy.gov/eere/amo/advanced-manufacturing-office-fy20-multitopic-foa-selections-table; Press Release, CEMEX Awarded a Grant From the U.S. Department of Energy to Adopt Innovative Carbon Capture Technology, CEMEX (Nov. 9, 2020), https://www.cemexusa.com/-/cemex-awarded-a-grant-from-the-u-s-department-of-energy-to-adopt-innovative-carbon-capture-technology.

111 Ben King, Clean Products Standard: A New Approach to Industrial Decarbonization, Rhodium Group (Dec. 9, 2020), https://rhg.com/wp-content/uploads/2020/12/Clean-Products-Standard-A-New-Approach-to-Industrial-Decarbonization.pdf.

112 Stashwick, supra note 70.

113 Committee on Energy and Commerce, Summary of the Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act, U.S. House of Representatives (Jan. 2020), https://energycommerce.house.gov/sites/democrats.energycommerce.house.gov/files/documents/Section-by-Section%20of%20CLEAN%20Future%20Act%20.pdf.

be developed and low-embodied concretes will not be procured. And if performance data is not made available to a wide range of participants, including new entrants, the competition necessary to spur innovation in the concrete and cement industry will not occur.[114]

Embodied-carbon metrics. Nationally recognized processes for measuring, publicly reporting, and labeling the carbon content of cement are needed. Congress should task a federal agency like the EPA with developing uniform embodied-carbon metrics for products sold in the United States.[115] It should also develop a public clearinghouse to track embodied-carbon data.[116] Additionally, Congress or state legislatures could require concrete and cement manufacturers to gather and publish consistent data regarding the embodied carbon of their products. Data transparency could be imposed as a condition of receipt of grants or contracts.

Fund NIST. Congress should increase funding for the National Institute of Standards for measurement science related to low-carbon and carbon-sequestering cement concrete. NIST should reevaluate existing industry standards, develop fast-tracked performance-based standards where such standards have not yet been developed, establish a standard method of measuring life-cycle emissions reductions, and ensure that any data gathered is made open-access.[117] The fast-tracked performance-based standards would work in tandem with less restrictive grant or award criteria to help push innovative technology to the commercial market.

COMPETITION

Federal and state enforcers must ensure that the industry remains competitive. As research into clinker substitutes and novel cements has grown, albeit too slowly, so too has dominant firms' interest in purchasing the intellectual property resulting from this research. As of 2018, ten corporations and organizations held 20 percent of clinker substitute patents.[118] Should policymakers do more to incentivize low-carbon products, corporations could become yet more aggressive in acquiring IP, further preventing the demonstration and uptake of low-carbon and novel cements and concretes. Regulators should keep a close eye on IP consolidation as part of a broader strategy to prevent further monopolization of the cement and concrete industries.

114 Lehne and Preston, supra note 11, at 64.

115 Rightor et al., supra note 96.

116 Id.; Lucca Henrion et al., Bendable concrete, other CO2-infused cement mixes could dramatically cut global emissions, Washington Post (Feb. 28, 2021), https://www.washingtonpost.com/health/cement-concrete-climate-change-emissions/2021/02/26/8afec166-7154-11eb-b8a9-b9467510f0fe_story.html.

117 Congressional Testimony of Dr. S. Julio Friedmann before the Committee on Energy and Commerce, U.S. House of Representatives, 115th Congress (Oct. 21, 2019), https://congress.gov/116/meeting/house/109943/witnesses/HHRG-116-IF18-Wstate-FriedmannJ-20190918-SD001.pdf.

118 Id. at 28, 33.

Competition/Merger Review

The FTC and Department of Justice should systematically review completed mergers and acquisitions in the cement industry. They should also require relevant companies to submit post-merger data, which the FTC could use to understand market competition at the regional and national level. In the review process, the agency should evaluate the effectiveness of remedies used to preserve competition, especially divestitures. While the below list is far from comprehensive, three major transactions in particular deserve attention:

1. Lafarge S.A./Holcim Ltd. $25 billion merger (2015): Settled FTC charges by divesting more than ten cement plants, quarries, and terminals.[119]

2. HeidelbergCement AG/Italcementi S.p.A. $4.5 billion merger (2016): Settled FTC charges by divesting more than ten cement plants and distribution terminals.[120]

3. Martin Marietta/Bluegrass Materials $1.635 billion merger (2018): Settled DOJ charges by divesting multiple quarries in Maryland and Georgia.[121]

In addition to reviewing past mergers, the enforcement agencies should include an analysis on low-carbon technology investments and partnerships in all pending and future mergers. While it is difficult to predict prospective anticompetitive harms, the cement industry is already experiencing an influx of capital from dominant companies directly or indirectly engaged in their sector. While the flow of capital into the sector is positive, enforcers should ensure that dominant firms do not engage in "killer acquisitions" to thwart smaller rivals. Moreover, the merger review and evaluation process should consider the consolidation of ownership stakes in the nascent low-carbon cements sector, including but not limited to IP ownership transfers.

119 Press Release, FTC Requires Cement Manufacturers Holcim and Lafarge to Divest Assets as a Condition of Merger, FTC (May 4, 2015), https://www.ftc.gov/news-events/press-releases/2015/05/ftc-requires-cement-manufacturers-holcim-lafarge-divest-assets. energycommerce.house.gov/sites/democrats.energycommerce.house.gov/files/documents/Section-by-Section%20of%20CLEAN%20Future%20Act%20.pdf.

120 Case Summary, In the Matter of HeidelbergCement AG and Italcementi S.p.A., Federal Trade Commission (November 15, 2016), https://www.ftc.gov/enforcement/cases-proceedings/151-0200/heidelbergcement-ag-italcementi-spa-matter.

121 Press Release, Justice Department Requires Martin Marietta to Divest Quarries to Preserve Competition in Connection with Its Acquisition of Bluegrass Materials, U.S. Department of Justice (Apr. 25, 2018), https://www.justice.gov/opa/pr/justice-department-requires-martin-marietta-divest-quarries-preserve-competition-connection.

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