NRDC Comments to the California Air Resource Board (CARB) on Embodied Carbon in Buildings Workshop 1

I. Introduction

The Natural Resources Defense Council (NRDC) appreciates the opportunity to provide comments in response to the California Air Resource Board's (CARB's) First Workshop on Embodied Carbon in Buildings. NRDC is a membership-based environmental organization with a strong interest in California meeting its decarbonization targets in an efficient, cost-effective, and equitable way.

California has long been a leader in adopting and implementing climate policy and is working toward a target to reach a net-zero greenhouse gas economy by 2045. To meet these targets, California will need to address embodied emissions of materials. As demonstrated in the Carbon Leadership Forum (CLF)'s California Carbon Report, greenhouse gas emissions of embodied carbon are projected to far exceed operational emissions in California buildings over the next 60 years.[1]

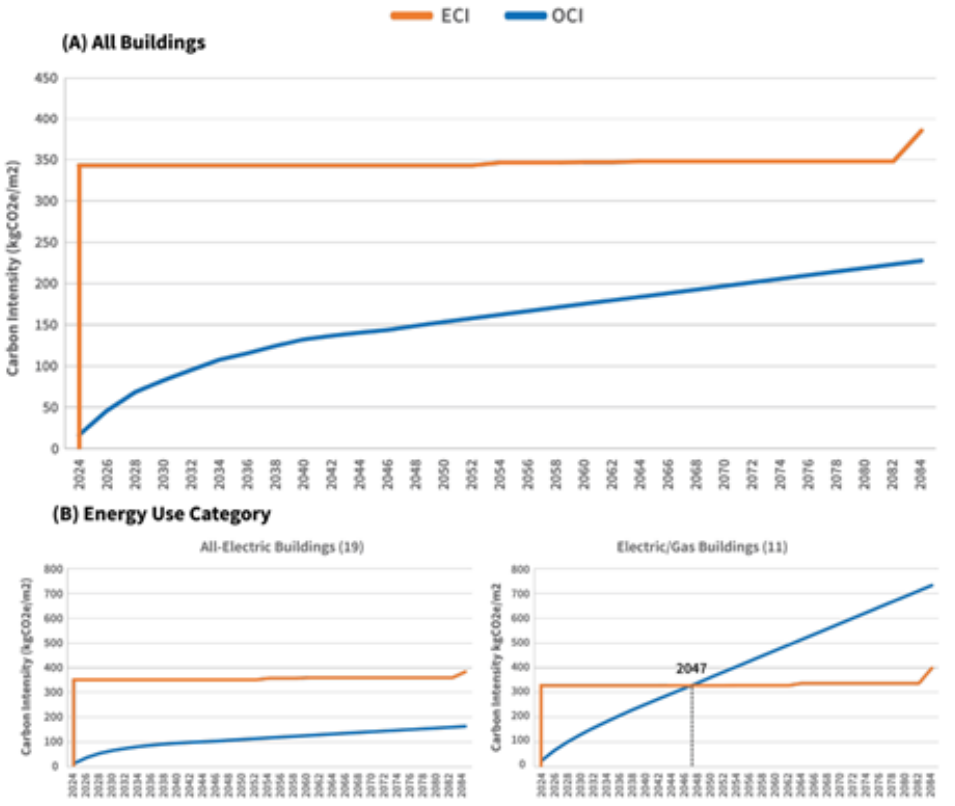


Figure 12. Median cumulative embodied carbon intensities (ECIs) and operational carbon intensities (OCIs). Results are shown for all buildings (A) and separated by energy use category (B) over a 60-year reference study period.

[1] CLF California Carbon Report, 2024, available at https://carbonleadershipforum.org/california-carbon/.

In recognition of this, in 2022, the California Legislature adopted, and the Governor signed AB 2446 (Holden), which requires a reduction of embodied carbon of building materials of 40 percent by 2035. This legislation was followed by AB 43, which amended some statutory deadlines and authorized the Air Resources Board to establish a voluntary emissions trading system as an implementation mechanism to meet the embodied carbon emissions reductions required in AB 2446.

While there are several existing programs at the state, county, and city level that address embodied carbon of materials, implementation of AB 2446 and AB 43 offers the state an opportunity to bring all of these efforts together to form a cohesive, coordinated, statewide strategy to measure and reduce embodied emissions of materials. As policies and programs that address embodied carbon are more recently adopted than emission reduction policies that target other sectors, there is significant low-hanging fruit that will be cost effective to implement.

For example, since projects are typically not designed to minimize use of materials, there are many opportunities to reduce embodied carbon by reducing material quantities. This can often reduce costs. In addition, most markets have shifted away from using ordinary Portland cement (OPC) in favor of Portland Lime Cement (PLC, or Type 1L), which delivers an embodied emissions reduction of approximately ten percent. In California, the market is just starting to shift, and the state could achieve significant reductions just by fully implementing this change. Using PLC rather than OPC would result in approximately a five percent total building embodied carbon reduction on its own. There is an enormous opportunity to increase blending of cement and use more SCMs in concrete to achieve deeper emissions reductions.

This new statewide embodied carbon reduction program can complement existing programs and establish a framework for embodied emission reductions in California.

II. Background: Existing Programs

California and counties and cities within the state are implementing, have adopted, or are considering adopting various policies that address embodied emissions of materials. These include:

- Buy Clean California: Adopted in 2017 and currently being implemented. Requires materials including flat glass, mineral wool insulation, and certain types of steel used in state projects to be below certain GWP limits.
- SB 596 (Becker, 2021): Adopted in 2021, currently being implemented by CARB. Requires all cement used in California to be net-zero emission by 2045.
- CALGreen Embodied Carbon Amendments: Adopted in August 2023 and beginning implementation in 2024, offers three compliance pathways for large commercial buildings to address embodied carbon emissions.

- Marin Low Carbon Concrete Ordinance: Adopted in 2019 and implemented in 2023, requires concrete used in Marin County to meet certain GWP limits and cement maximums for different strengths of concrete.
- Santa Monica Low Carbon Concrete Ordinance: Adopted in spring 2024, modeled after the Marin Low Carbon Concrete Ordinance.
- LA City Embodied Carbon Code: Adopted by the City Council in April 2024, to be implemented by the Los Angeles Department of Building and Safety. Would update the Los Angeles Green Building Code to create a framework that sets limits on the embodied carbon allowed for new construction of and major additions to buildings larger than 50,000 square feet.
- Dublin Low Carbon Concrete Ordinance: Adopted in September 2024, modeled after Marin Low Carbon Concrete Ordinance.

This non-exhaustive list includes efforts underway to reduce embodied emissions of materials. Some of these programs are already generating data and information on the embodied emissions of materials used in California and could provide a valuable source of information for CARB to pull from as it develops baselines. In addition, some of these programs may offer valuable lessons on best practices for data collection and may provide a model CARB can complement or expand as it develops a framework and benchmarks for a broader set of projects.

While these various programs may each have their own implementation mechanism and there is value in CARB ensuring consistency with statewide embodied carbon reduction requirements, it is also important to ensure that municipalities striving for more aggressive emissions reductions than required under AB 2446 are able to continue in that leadership role.

Of particular interest to NRDC is how AB 2446 implementation can complement SB 596. SB 596 requires all cement used in California to be net-zero emission by 2045. Many interventions to reduce embodied emissions from cement are at the project level and concrete level, rather than the cement plant level. For example, since cement is the largest contributor to concrete's large carbon footprint, simply reducing the amount of cement in concrete can reduce embodied emissions of that concrete by up to 50 percent. As SB 596 does not give CARB explicit authority to regulate concrete or projects, complementary policies such as AB 2446 will be required to unlock deployment of some of the most cost-effective concrete emissions reduction strategies such as clinker substitution, optimizing mix design to use less cement, and optimizing project design to use less concrete.

III. Responses to Request for Feedback

How might CARB address data limitations for bottom-up and top-down approaches to assess GHG emissions?

While in an ideal world a baseline would be calculated based on robust the robust data collection approach outlined on slide 38 of the 9/19/24 Workshop Slides, we acknowledge that it would be

difficult to do a bottom-up baseline calculation in a meaningful way at this time. The paucity of project LCAs and emissions from individual products means that establishing a baseline will rely on some level of modeling in either case to fill in information gaps. The top-down approach identified on slide 37 of the Workshop Slides provides an approach to setting high-level goals. It would be beneficial to use a combination of a top-down and bottom-up approach.

For the purpose of identifying and defining a starting point for the 40% emissions reduction called for in AB2446, the high-level approach is appropriate. It allows for a clear calculation of emissions at a point in time, without the need for detailed data collection at the building and project level. The downside of this approach is that it uses general emissions factors, rather than regional specific values. For cement and concrete, we know these vary substantially between northern and southern California, due to the materials used in mixes, and their sources and transport. The top-down approach also does not show demand-side strategies that might lead to more square feet of building with a similar quantity of cement or concrete.

To track meaningful progress over time, a more detailed analysis will be needed. Because California is a large geographic area, any bottom-up approach will have to extrapolate from existing data sources, using representative samples to estimate quantities and emissions for the various products and companies throughout the state.

Therefore, we believe the best approach is one that uses both existing data and prioritizes data collection for the most important variables for which information is missing. California will likely need to develop a repository of this data to house data values unique to California such as regional suppliers, fuel factors for transportation within the state, typical building types, average building size, average lifespan of building, base materials in CA building code, and the standard practice for waste and disposal of materials before, during, and after construction.

Is one baseline-development approach preferable?

As previously discussed, whichever baseline development approach the agency moves forward with should depend on data availability for key variables. For example, in Portland, Oregon's Low-Carbon Concrete Initiative, local government used a bottom-up approach to identify a performance baseline. A CLF report[2] studying the implementation of public procurement policies highlighted the process in which the City of Portland benchmarked previous procurement practices. The City requested maintenance records and concrete quantities from major suppliers that also had EPDs for their mixes. Baselines could be easily established for different categories of public works i.e. maintenance work and water infrastructure projects.

[2] CLF Implementing Buy Clean Report, pg.11, available at https://carbonleadershipforum.org/implementing-buy-clean/.

The city of Vancouver also took a bottom-up approach, coupled with modeling efforts, for their embodied carbon emissions reduction targets in the Vancouver Building By-law.[3] Ahead of the city's embodied carbon guidelines, the city conducted an embodied carbon baseline and reduction study. The baseline development calculation used three different common building archetypes in Vancouver. A combination of rezoning applications and prior project materials from the consultant generated a generic design to use in a parametric LCA study. Data input into the 700,000+ models LCA were from the Athena Impact Estimator tool and industry average and product-specific EPDs. Additional information from the study can be found here.

For statewide benchmarking a top-down approach is preferable. For measuring progress over time, a bottom-up analysis, based on aggregated whole building or whole project LCA data, will be needed.

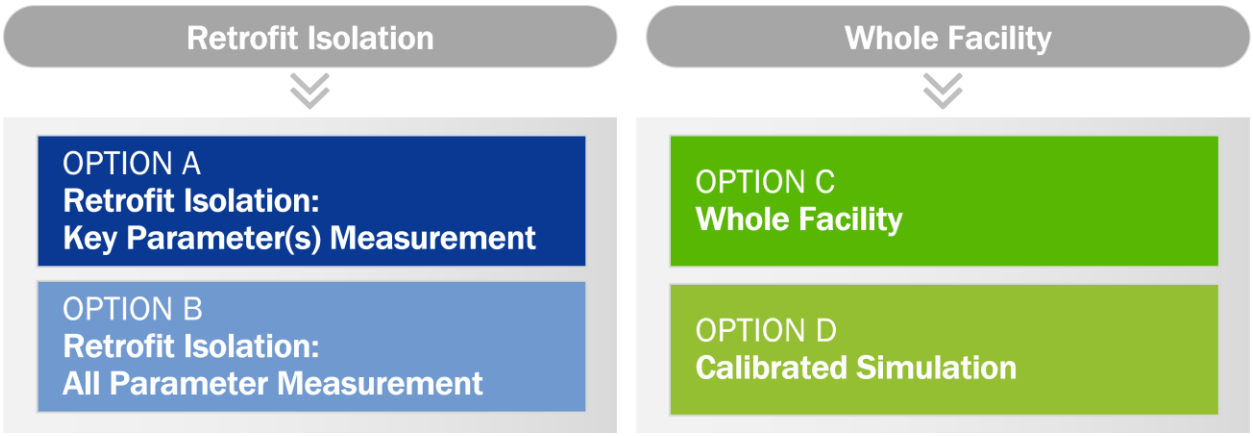
What additional factors for baseline development should CARB consider?

City approaches: Several cities have started developing or researching baseline approaches for calculations of embodied carbon savings. The City of Vancouver, in its Embodied Carbon Guidelines 1.0 (2023), establishes two approaches for developing a baseline from which to calculate carbon reduction. The first approach is to calculate the embodied carbon of the proposed design. The second approach uses a modeled baseline based on three different building types in Vancouver. The City of Los Angeles, in an April 2024 motion, instructs the Department of Buildings and Safety to develop a report with recommendations on updating the Los Angeles Green Building Code to include embodied carbon. The report is to include 1) defining baseline models to be used in WBLCAs against which GWP reductions can be measured, and 2) collecting and analyzing WBLCA data for the purpose of developing and publishing benchmarks by building typology against which GWP reductions will be measured.

IPMVP: For calculation of extrapolation of for estimating statewide emissions reductions, NRDC offers the international EVO International Performance Measurement and Verification Protocol (IPMVP) for energy efficiency measurement and verification as a conceptual framework. Under Evo, IPMVP option C is recommended for instances where using whole building input data is available and can be coupled with a model to assess reductions. This is consistent with whole building LCAs. IMPVP Option D suggests a calibrated simulation for instances where data for the baseline or reporting period are unavailable.

IPMV Measurement Boundary options table:[4]

[3] Vancouver Embodied Carbon Strategy and related documents, https://vancouver.ca/green-vancouver/zero-emissions-buildings.aspx#embodied-carbon.
[4] https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp.



Compliance with standards: Compliance with existing standards will be key for whole building LCAs and their associated baselines. Standards play an important role in prescribing data quality requirements, methods for assessment, and uncertainty calculations. These standards are foundational to reliable and comparable baseline calculations. Core standards CARB should seek compliance with include:

- European Standards: EN 15978:2011, Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method.
- The UK's Royal Institute of Chartered Surveyors (RICS) Whole life carbon assessment (WLCA) standard, 2nd edition.
- National Research Council Canada's National whole-building life cycle assessment practitioner's guide.
- (Soon to be published) Structural Engineering Institute (SEI)'s Prestandard for Assessing the Embodied Carbon of Structural Systems for Buildings.
- Proposed ASHRAE/ICC Standard 240P – Quantification of Life Cycle Greenhouse Gas Emissions of Buildings.

Is there existing information we could rely on for baseline setting?

NRMCA regional baselines: NRDC suggests CARB consider use of the NRMCA regional baselines. NRMCA has been conducting a survey of its members that produce project-specific third-party verified LCAs or EPDs to compare the environmental impacts of their products with industry averages. The latest regional benchmark report, A Cradle-to-Gate Life Cycle Assessment of Ready-Mixed Concrete Manufacturers by RNMCA members – Version 3.2 was published in July 2022. Appendix C of the report contains industry average GHG emissions by concrete strength class for their members, broken down into nine US regions. California is in the Pacific Southwest region together with Nevada and Arizona. Using funds from a recently received US EPA grant, NRMCA plans to expand the regional benchmark values from nine to 30 by the end of 2025, and to 50 regions by 2029. A key advantage to using these benchmarks is that they are nationwide, enabling comparability of data and measuring progress relative to other states that do not have policies in place to lower embodied carbon.

CALGreen: We strongly encourage CARB to start a statewide database of whole building embodied carbon data collected for CALGreen compliance to use that data for setting benchmarks. As cities are at the forefront of requiring embodied calculations and collecting data on compliance, they are one of the best sources of information on actual projects in the short term. CARB can coordinate with other entities collecting WBLCA data to ensure consistency and verification of data and methodologies.

ECHO: We also strongly encourage alignment with the ECHO Reporting Schema protocol published last month. The ECHO Project is a collaboration of leading firms in North America working on embodied carbon that have come together to seek alignment on "life cycle assessment (LCA) scope, methodology, terminology, and other factors result in inconsistent reporting that impedes comparison, benchmarking, or setting reduction targets."

Priopta: Priopta has a graphic reporting tool for whole building embodied carbon that can be referenced for baseline setting.

In addition to the sources above, we recommend CARB consider the embodied carbon calculation methods used by existing accreditation and certification bodies:

1. LEED v4 and 4.1(beta) Materials and Resources Credit Building Product Disclosure and Optimization.
2. International Green Construction Code (IgCC) – California is one of the 13 US states and the District of Columbia that have adopted the IgCC, a a whole systems approach to the design, construction and operation of buildings. The code is a public-private collaboration that provides green model code requirements for jurisdictions to adopt and implement.
3. GBI's Green Globes for New Construction – provides 150 of 1000 points for materials used.
4. Envision CR1.1 Reduce Net Embodied Carbon.

What is the appropriate level of data for this program to track progress towards the target?

NRDC recommends CARB require type III facility or product specific-EPDs. In order to be able to choose among products, information on the emissions from the plant and supply chain specific to that product is essential. For this reason, industry average EPDs are insufficient. Any EPD that averages emissions across products from the same industry has the potential to hide the emissions of an especially emissions-intensive production process, and inadvertently incentivize products associated with it. This is especially true when considerable emissions variation exists across different producers for the same material.

Facility-specific EPDs are quickly becoming the standard for calculation of embodied carbon emissions reduction. They are required in IRA funded, low-carbon procurement programs

through multiple federal agencies, including the U.S. General Services Administration (GSA) and the Department of Transportation (DOT), via an interim determination from the Environmental Protection Agency (EPA). Additionally, facility and product-specific EPDs are outlined in guidance from New York State in Executive Order 22, Oregon DOT, and Colorado's Office of the State Architect (OSA) Buy Clean Guidance.

In addition, there should be a mechanism to assess materials that are replaced frequently like carpet and paint, calculating their emissions over the life of the building.

What suggestions do you have for overcoming limitations to EPD generation and collection?

At present, availability of EPDs is limited for products beyond concrete and cement. Even for concrete and cement, not all producers are equipped to create EPDs for their products. There is likely a need for incentive funds to help small-medium producers become outfitted to produce EPDs. While the cost of producing a third party verified facility specific concrete EPD has come down considerably in recent years[5], it is still in the $3,000 - $5,000[6]/plant range depending on the number of facilities the producer has. However, after EPD software and information is set up for an individual plant, most EPD software systems allow for generation of "instant EPDs" for any concrete mix. Additionally, the process of collecting source information for all inputs is a considerable administrative burden, akin to undertaking an audit or filing itemized taxes, for which smaller producers may not see a benefit unless they know there is a business reason to do so.

Some states are providing incentives for EPD production. Massachusetts, for example, has an EPD grant program available via a partnership between the Massachusetts Clean Energy Center (MassCEC) and the Massachusetts Concrete and Aggregate Producer's Association (MaCAPA) to support concrete ready-mix producers in developing EPDs. MassCEC offers grants of $3,000/plant with at least five acceptable third-party verified EPDs, and an additional $1,000 for companies that only have one or two plants. The MassCEC program allows use of any software and third-party verification as long as instant type III EPDs can be provided that comply with ISO 21930 and the North American PCR for Concrete, NSF International, August 2021 v2.1.

The state of Oregon's Concrete Environmental Product Declaration Program offers a more comprehensive approach. Starting in 2016, the OR DEQ has partnered with an industry association, the Oregon Concrete and Aggregates Producer Association, to provide free access to a web-based EPD tool, limited technical assistance directly to businesses, and a reimbursement

[5] In 2017 generating an EPD cost $13,000 - $40,000 and took 20-40 days of administrative work. https://www.sciencedirect.com/science/article/pii/S221282711631318X#:~:text=The%20total%20cost%20for%20creating,and%20characteristics%20of%20EPD%20programs.

[6] Based on conversations with EPD producers WAP and Climate Earth in 2024. Climate Earth has suggested that their EPDs are closer to $2,000 – $5,000/plant.

incentive. The cost of the initial contract was $85,000 with annual fees of $6,000 to maintain access to the web-based tool.

Both the MassCEC program and Oregon EPD program are examples of EPD assistance provided at relatively low cost.

For asphalt, the National Asphalt Pavement Association provides their Emerald Eco-Label EPD tool free to members. The software allows asphalt mix producers to develop and publish verified mix-specific, plant-specific EPDs for asphalt mixtures produced in the United States. The tool is web-based and includes an optimizer offering that allows companies to optimize plant operations and mix designs by identifying hot spots in the process, while offering options to reduce emissions.

It's also worth noting that the US EPA recently awarded $160 million to support development of EPDs and EPD inputs for low carbon materials. Under the program, 38 entities received awards.[7]Some of the recipients are located in California, and entities like NRMCA or the Portland Cement Association will be providing pass-through grants for which California entities are eligible. Awards include EPD development and verification, creating of EPD data platforms and integration, and data inputs for EPDs, among others.

What local, state, federal reporting can be leveraged?

NRDC recommends that CARB seek an approach consistent with the US EPA's EPD and carbon labeling programs to ensure alignment and interoperability with current and developing federal standards.

Where possible, we recommend CARB utilize and build upon the Federal LCA Commons database. The Federal LCA Commons is an interagency community of practice for Life Cycle Assessment (LCA) research methods, via a formal agreement between the USDA, Department of Energy, and the Environmental Protection Agency.

We also recommend building on existing efforts at the US Department of Energy. These include the LCA GREET model, currently used by CARB in the Low Carbon Fuels Standard[8] to calculate the carbon intensity of different fuel pathways.

This summer, the US DOE's Industrial Efficiency and Decarbonization Office (IEDO) announced plans to create a Low-Carbon Cement and Concrete Center of Excellence to accelerate development and adoption of novel low-carbon cement and concrete technologies. The center of excellence is intended to address the following priority areas: 1) test method and development, 2) modeling, 3) data collection and monitoring, and 4) carbon accounting. The carbon accounting will involve "methodologies for calculating and reporting emissions in

[7] Description of awards and those with pass-through grants: https://www.epa.gov/system/files/documents/2024-07/2024-epd-grant-summaries-ira-60112-final-7.15.24.pdf.
[8] CARB uses a California specific version of the model, https://www.lifecycleassociates.com/lca-tools/ca_greet/.

selected applications" compared to "a designated baseline." This work will leverage in-house material testing and be used for LCAs and to support EPDs.

Existing green public procurement policies and their respective reporting streams can be leveraged for CARB's embodied carbon strategy. Utilizing existing data collection processes within the agency and partner agencies can create a robust data set and minimize the capacity needed to stand up unique reporting processes for the implementation of AB 2446.

Federally, the U.S. General Services Administration (GSA) has had a successful launch of its low embodied carbon (LEC) program. Since 2023, an additional 17,000 North American EPDs have been published across the concrete, asphalt, glass, and steel industries. These EPDs are publicly available and will likely continue to increase as additional federal support for EPD generation and verification become available. There are also other nationwide programs CARB can draw regular data from such as the U.S. Green Building Council LEED certification program. Various credit requirements in the Materials and Resources category within the application collect LCA and EPD data that can be relevant to CARB's reporting needs.

Complementary to California's GHG inventory, the state's Buy Clean law and CALGreen building codes are other sources of data to pull from. Many localities across California have also begun to collect EPDs and other relevant data for their low-carbon concrete ordinances. These localities include but are not limited to Marin County, Dublin, and Santa Monica.

How should CARB collect cost data from manufacturers and builders?

NRDC recommends that CARB undertake a statewide cost study, modeled on the California Energy Commission's energy efficiency Commercial End-use Survey (CEUS) or other statewide research. The CEUS study is conducted regularly and collects data from selected commercial businesses within the state of California. Project participants are randomly selected by utility service area, climate region, building type, and energy consumption level to provide an accurate statewide sample by NAICS code.

CARB should also seek to conduct regional supply chain surveys to 1) understand supply, 2) collect and assess cost information, and 3) verify EPD values. California can use such surveys to augment its data collection through EPDs. Information on regional supply chains will be extremely helpful in identifying diffusion of low carbon materials into markets, availability of local supply, and cost of available options.

IV. Other topics

Section K of AB 2446 requires CARB to:

> (2) Evaluate measures to support market demand and financial incentives to encourage the production and use of materials used in construction-related projects with low greenhouse gas intensity, including, but not limited to, consideration of both of the following measures:

(A) **Measures to expedite the adoption for use in projects undertaken by state agencies,** including the Department of Transportation and the Department of General Services.

As other state agencies including the Department of Transportation (Caltrans) and the Department of General Services (DGS) are significant users of materials with high embodied emissions, there is substantial opportunity to align this program with programs within Caltrans and DGS to achieve maximum embodied emissions reductions. One such program is Buy Clean California, which sets emission limits for glass, insulation, and steel used in state projects. CARB should recommend that 1) Buy Clean California's covered materials list be expanded to include concrete and asphalt, and 2) CARB should assess additional programs to drive down embodied emissions of materials used in state projects.

V. Conclusion

A coordinated and methodical embodied carbon strategy is critical to achieving the emissions reductions targets outlined in AB 2446. The successful implementation of this law will greatly affect not only building decarbonization efforts statewide but will help unlock industrial decarbonization pathways, including those for cement and concrete. To this end, we are especially looking forward to identifying opportunities for AB 2446 to complement SB 596, California's net-zero cement law, as well as engage in development of methodologies to establish baselines. NRDC appreciates the opportunity to provide comments and looks forward to working with CARB and other stakeholders in crafting California's embodied carbon strategy.

Sincerely,

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