Marin County Low Carbon Concrete Code Development and Adoption Process

This outline of the year-long process from initiation to adoption of Marin County's Low Carbon Concrete Code is provided to serve other jurisdictions interested in pursuing a similar code amendment. Other jurisdictions' experiences will vary due to local supply chain, construction industry, economic and political landscapes. The lessons from the Marin County process can inform a similar code amendment specifically on concrete, or can be adapted to address other or multiple materials.

Before You Get Started: Choosing Your Scope

Concrete was selected as the focus of this project based on its emissions magnitude and reduction potential. Concrete is the biggest contributor to embodied carbon emissions in buildings and there are known substitutions and mix/process modifications that can lower its embodied carbon. It was also missing from the AB 262 Buy Clean Act of California which specified four other building materials.

This project occurred in 2018-2019. During this time and since, the conversation around embodied carbon has continued to evolve and mature. Other leading policymakers are considering whole building approaches that address more than concrete. A limitation of the GHG reduction potential of a code amendment that only addresses concrete mixes is that it does not restrict or address the total amount of concrete in a project. In contrast, a whole building LCA approach or perhaps prescriptive design guidelines for whole buildings can encourage using less concrete and other carbon-intensive materials. It may be helpful to begin by considering the options along two variables:

Table 1: Embodied Carbon Policy Options

	Prescriptive	**Performance**
Specific Material(s)	Attribute (e.g. max cement content, recycled content)	Global Warming Potential limits in Environmental Product Declarations
Whole Building	Design guidelines (e.g. building reuse, mass timber)	Whole building LCA

The Marin County code amendment addressed both prescriptive and performance options under a specific material.

Keys to success: Consider what is both feasible and impactful in your jurisdiction. This includes an assessment of market readiness, building stock and anticipated construction, political appetite, and resources to support industry transitions, such as trainings and access to necessary tools (e.g. LCA calculators). It also includes political sensitivity around targeting specific industries, and how far beyond current practice is the right stretch at this time. It may be helpful to consider the first code action in the context of a future roadmap of a constellation of actions to deliver the jurisdiction's long term embodied carbon goals.

Phase 1: Assembling a Team

The project benefitted from key champions that initiated the process and continued to actively contribute through the adoption phase. A small group was formed with additional members that were dedicated to seeing the code through to completion. Each team member's role is described in Table 2.

Champions:

- **Municipal (internal) champions:** Bill Kelley, Chief Building Official and Alice Zanmiller, Sustainability Planner and the lead for administering this project
- **Private sector (external) champion:** Bruce King, structural engineer, Ecological Building Network (EBN), and Marin County resident

Additional Core Team:

- **Private sector:** Frances Yang, structural engineer at Arup
- **Academic sector:** Kate Simonen, director of Carbon Leadership Forum (CLF) and UW professor of architecture
- **Public sector:** Miya Kitahara, StopWaste (a joint powers agency in a neighboring county)

Keys to success: A combination of internal and external champions strengthens the team. Champions need to be committed to working through to the end of the process and collaboratively with a well-rounded team. Especially within the adopting agency, a project lead should be given resources and commitment to follow through beyond adoption to the implementation phase of the code. They need to be able to craft the ordinance, codification and enforcement procedures to be short, simple, understandable, and easy to demonstrate compliance. Consider the complimentary roles and contributions that each team member brings, and identify any gaps or roles that are not represented.

Phase 2: Fund Seeking

The team came together around a funding opportunity through the regional Bay Area Air Quality Management District. They offered a Climate Protection Grant, which was open to local government agencies in the Bay Area and could fund the work of subcontractors/consultants from the private sector. Marin County led the proposal, with content input from the rest of the team. The funding specifically sought to reduce GHG emissions, so the proposal included technical assistance to actual projects that would be pouring concrete within the grant's required timeframe (within 4 years of the proposal) for which GHG reductions could be calculated.

The total grant received was just over $200,000 and broke down into five tasks. The table below shows the structure of the core team and approximate budgets allocated to each task.

Table 2: Tasks and Team

Task	Approx. Budget	Lead Team Members
1. Establish regional working group with 8 meetings	$40,000	CLF, with all participating
2. Develop code language and specifications	$90,000	EBN (res), Arup (nonres)
3. Adopt code in Marin County	$25,000	Marin County
4. Pilot projects	$30,000	Arup
5. Disseminate support to other jurisdictions	$15,000	Marin County, StopWaste

Some of these tasks and budget were uniquely required for the first jurisdiction to develop this code. This scope was designed to create supporting documents to ease replication by other jurisdictions, so that the resource needs for subsequent jurisdictions should be less. However, some jurisdictions may face increased cost if they have more complicated concrete construction sectors that require more nuanced stakeholder engagement.

Keys to success: Look for flexible funding sources or ones that are broad enough to address embodied carbon. Many climate action funding sources target operational emissions or scope 1 and 2 emissions only. BAAQMD may be unique in their comprehensive perspective of GHG emissions, which allowed embodied carbon to be included. Pre-work may need to be done to establish rapport with funders and expand their scope of climate action.

Phase 3: Stakeholder Meetings

Through the fund seeking process, the team had solicited letters of support from firms and organizations in the Bay Area. Many of these came from the Carbon Leadership Forum community. The team invited those who had submitted letters of support to join the year-long, 8-part series of stakeholder meetings. Recognizing the significant time commitment of joining this group, the team offered other opportunities for less intensive engagement for input and feedback during the year.

To structure the process, the team formed the Bay Area Materials Working Group on Low Carbon Concrete Codes. Below is the list of participants that volunteered substantial time to engage in the full process. Several of these participants were not specific to the local context, and could be helpful resources for engagement in other regions.

Academia & NGO

- Mark Aschheim, Santa Clara University
- Guarav Sant, UCLA
- Wil Srubar, Colorado University, Boulder
- Wes Sullen, US Green Building Council

Concrete Industry

- Alana Guzzetta, Central Concrete/Us Concrete
- Tien Peng, National Ready Mix Concrete Association
- Hernan Jose Perez, Cemex

Government

- Karen Cook, Alameda County
- Eden Brukman, City/County of San Francisco
- Sarah Moore, City of Berkeley

Building Industry

- Kimberly Loscher, Skanska
- Eric Peterson, Webcor
- Ryan Bell, University of California Office of the President

Table 3 contains a timeline of the process undertaken by the working group.

Additional stakeholder engagement: In addition to those listed above, early review and comments were provided by other interested stakeholders including those from Central Concrete, Climate Earth, Lehigh NW Cement Company, California-Nevada Cement Association, and Sierra Club. Marin County also held an in-person meeting specifically with smaller suppliers in Marin County to discuss anticipated impact to their businesses. The internal project lead also met with other County departments that would be affected, specifically Department of Public Works (DPW) and Parks.

Table 3: Working Group Process

Meeting # & Format	Topic	Date
1 (virtual)	Kick-off and process overview	11/8/18
2 (virtual)	Scope of specifications and local government parameters for codes	12/13/18
3 (virtual)	Presentation of code/specs and initial feedback	1/10/19
4 (in person)	Work session to refine specifications	3/8/19
5 (virtual)	Input on outstanding questions	5/9/19
6 (virtual)	Presentation of initial code language	6/13/19
	Disseminate draft for broader community input	Jun-Jul 2019
7 (in-person)	Work session on code language and final specs.	7/17/19
8 (virtual)	Final review of model specs and code language	8/1/19
	Dissemination for formal input	Aug-Sep 2019

Keys to success: Start with the Carbon Leadership Forum community to find firms and organizations in your region. Your region may already have a CLF hub as a starting place. Invite representation from each of the affected sectors, particularly anyone whose business model and revenue/expenses may be affected by the code amendment. The concrete industry is more adaptable to the code than the cement industry, so consider different ways of engaging these two industries. Consider the range of affected project types and whether the representation covers all types. This may mean proactively engaging smaller local builders and suppliers, which are less likely to have staff that can readily participate in a rigorous stakeholder process. If key stakeholder groups or representatives are unable to commit to the full process, map out the key points for their input.

Phase 4: Draft Structure and Thresholds

Through the stakeholder process, the engineers on the project team led technical development of 1) the structure of the code requirements, and 2) thresholds within different pathways of that structure.

Structure. The Marin Code contains four pathways for compliance:

Cement Limit Method by Mix	Embodied Carbon Method by Mix
Cement Limit Method by Total Concrete Volume	Embodied Carbon Method by Total Concrete Volume

The code needed to accommodate a range of projects. Along a spectrum from small to large, it was anticipated that smaller residential projects (designed by smaller firms and sourcing concrete from smaller local suppliers) would likely use the cement limit method whereas larger commercial or institutional projects (designed by larger firms and sourcing from the major concrete suppliers) might use the embodied carbon method. The mix-specific pathways are more straightforward, while the total volume pathways allow for flexibility between different uses of concrete on a project, where some applications require higher cement content (e.g. for quicker strength gain) but could "make up" for that addition by going below code on other applications within the project.

Thresholds. The group arrived at the limits through the stakeholder process and a review of mixes that have been poured for real projects in the Bay Area. A detailed description of this process is available as a separate document (PDF) at stopwaste.org/concrete.

The suppliers and contractors in the stakeholder group confirmed that the limits were feasible based on their in-depth and historical knowledge of the concrete mixes they collectively use on projects in the Bay Area. Their feedback led the group to set the limits at 10-30% below the NRMCA industry averages, and then provide a 30% allowance on applications needing higher early strength.

Below are additional links to support the threshold setting process:

- NRMCA industry benchmarks: https://www.nrmca.org/wp-content/uploads/2020/02/NRMCA_LCA_ReprtV3_20191112.pdf
- Suppliers with EPDs: https://www.nrmca.org/association-resources/sustainability/epd-program/
- EC3 is a searchable database of real EPDs for a variety of product categories that can be filtered by concrete strength and geography: https://www.buildingtransparency.org/en/

Allowances and Exemptions. Acknowledging that some applications necessitate higher cement content, the stakeholder group identified two reasons for allowable increases beyond the thresholds. The first allows a 30% increase over thresholds for applications that require high early strength. The second is an allowance for cement products that show low embodied carbon by plant-specific EPDs. The latter applies only to the cement limits, not the GWP limits. Additionally, the chief building official may grant exemptions for hardship or infeasibility for reasons such as lack of commercial availability, disproportionate cost increase, or historic preservation.

Keys to success: Consider the range of projects and ensure that the code structure is accessible by all effected project types. Conduct a review of existing mixes by engaging local engineers and concrete suppliers. Compare these findings to a benchmark such as the NRMCA averages, and take into account that regional mixes vary by availability and quality of raw materials for concrete; environmental conditions that may require different concrete performance; standards of practice; and market economics. The findings for the Bay Area will be different from other regions. The City of Portland is an example of a jurisdiction that conducted a similar process to define limits appropriate to its market. Solicit any potentially challenging application scenarios early in the process so they can inform the overall structure to include exemptions and allowances for these special cases.

Phase 5: Adoption

After the year long process, the code language was prepared for adoption. In Marin County's case, the Low Carbon Concrete Requirements chapter was added as a separate chapter under the Marin County Building Code. The local amendments to the state codes include amendments to the CBC, CRC and also CalGreen. This was intentional in order to ensure the reduced carbon requirements had a sweeping effect on all concrete placement in Marin (including County DPW projects in ROW and homeowner flatwork), not just placement for projects governed by applicable CalGreen provisions.

County staff prepared a brief oral presentation to the Board of Supervisors for a first and second reading, including public hearing, on Nov 5 and 19, 2019 respectively. During the adoption public hearings, members of the team who contributed to the code development process gave supporting public comment. Representatives from the concrete and cement industries gave public comment. The concrete presentative verified that the thresholds were feasible, and encouraged the Board of Supervisors to consider expanding embodied carbon requirements to other materials, not only concrete.

Keys to success: Through the stakeholder process, build a supportive network representing a cross-section of affected industries. Inform them when the code will be heard by the elected body and explain the public comment process and encourage them to participate. Particularly in jurisdictions less inclined to adopt policy solely for GHG reductions, be prepared to communicate the need for this action. The proposed requirement must be received as compelling, reasonable, and urgent. Any potential concerns should be understood before bringing the ordinance to a vote.

Phase 6: Implementation

After adoption of the code amendment, the County chief building official is responsible for implementing enforcement of the code. The code specifies that the building department will require documentation prior to issuance of applicable building permits and prior to approval of construction inspections following placement of concrete.

At time of permit issuance, the applicant will be required to complete a compliance form. The County began with a draft compliance form developed during the stakeholder process, and sought to find areas to simplify the form to ease its use by permit applicant. They also followed up with local suppliers to ensure that the documentation on batch receipts would provide the information needed for building staff to review for consistency with the compliance form.

At time of inspection, the building department will require batch certificates and/or EPDs and review that they are consistent with the information submitted on the compliance form. When deviations from compliance occur, the code specifies that the chief building official is authorized to require evidence of equivalent carbon reductions from the portions of remaining construction of the project to demonstrate alternative compliance with the intent of the code.

The building department staff is responsible for reviewing for compliance, and they expect the level of effort to be a small fraction of the overall permitting process. The extent of the training required is the chief building official showing the forms and sample mix documentation with an explanation of the protocol. The compliance forms and documentation will be retained in hard copy (anticipating minimal sheets of paper) and shared with the County's sustainability staff who will track the GHG reduction impacts attributable to the code every 1-2 years.

Additionally, the BAAQMD funded project provided technical assistance to five pilot projects to test the process of designing projects and specifying concrete mixes for compliance with the code. Case studies of the projects can be found at stopwaste.org/concrete. Compliance with the thresholds was found to be generally feasible, though the pilot project experience showed how helpful the additional technical assistance was for projects team to understand and comply with the requirements. Some points to watch for potential complication are:

- When multiple mixes are specified to achieve lower GWP limits, yet have the same strength (psi), when the project is in construction, teams may be inclined to pour the same (higher GWP) mix for efficiency.
- Seasonal shortages in fly ash may become more common due to closure of coal plants and cleaner burning technologies. The pilot project teams were mostly able to use slag instead. In the future, alternative cementitious materials such as ground glass pozzolan – that are not a direct byproduct of fossil fuel industries – are expected to enter the market.

- Additional applications needing high early strength that were encountered in the pilot project but not listed in the code language included retaining walls needing to be backfilled quickly, sidewalks that need to be open for traffic right away, and slabs on grade that need to support construction equipment. The general description of qualifying applications, as opposed to only offering a specific list, provided a sufficient catch-all for these when needed.
- It was not clear whether the requirements applied to site work and whether "precast" included concrete masonry units (CMU). The pilot projects were used to test the feasibility of the limits and process for these types of concrete applications and had mixed results. It is recommended that other jurisdictions clarify whether these are in or out of scope ahead of time.

Keys to success: During the code development process, work out the nuances that will enable or impede implementation. It may seem expeditious to defer implementation consideration until after the code is adopted, but there are many opportunities to ease implementation by designing for it during the code development process. Some keys to consider:

- Make compliance forms compatible with local suppliers' mix documentation.
- Require declaration from responsible person in charge at design phase to be in drawings.
- Require documentation at stages of the permitting process that catch potential for error.
- Forms of recourse available if noncompliant mix is poured (redoing the concrete defeats the purpose of the low carbon code).

Have dedicated staff that will be available throughout the code development, adoption, and implementation process. Develop the requisite public/private network for support needed to effectively implement the necessary changes once the ordinance is codified. Again, engaging local suppliers from the beginning is important for all of the steps of this process. Also be prepared to provide education and implementation resources to project teams (architects, developers, structural engineers).

Finally, capture performance data in the most non-burdensome way and regularly report the success of everyone's effort at reducing carbon in terms relevant to the public.

Building Momentum and Contributing to the Movement

The County of Marin undertook this effort with the intention of creating a replicable model and provide leadership for other jurisdictions to follow. The project team continues to encourage jurisdictions to consider the concrete code alongside other policy options available to local and state governments to reduce embodied carbon. The Carbon Leadership Forum has recently produced a policy toolkit, which lists the Marin code along with many others across the U.S. The Carbon Neutral Cities Alliance and its partners has also produced a City Policy Framework on Embodied Carbon describing a wide range of policy options. If your jurisdiction takes action, please share your experiences to continue building awareness and action collectively.

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