SEI STRUCTURAL ENGINEERING INSTITUTE ASCE | SE2050 COMMITTING TO NET ZERO

PCS Structural *Solutions*

PCS Structural *Solutions'* Embodied Carbon Action Plan (ECAP)

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PCS Structural *Solutions*

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Introduction

As a dedicated structural engineering firm, PCS Structural *Solutions* acknowledges the significant impact of our structural systems on the environment, both now and for future generations. Since committing to the SE 2050 Program in 2020, we understand the necessity of measuring and tracking the embodied carbon of structures on a national level, establishing benchmarks, and working towards reducing carbon emissions now and in the future. By providing sustainable project solutions, educating our staff and clients, and actively participating in national programs, PCS Structural *Solutions* aims to collaborate with other structural engineering firms across North America in our shared goal of achieving net-zero embodied carbon by 2050.

In our Embodied Carbon Action Plan (ECAP), we outline our internal and external commitments for 2025 and insights gained from our previous years of dedication. These commitments are a foundation for PCS as we advance our efforts toward net-zero embodied carbon by 2050. In the initial years, our ECAP has focused on educating our staff and clients about embodied carbon. Internally, we have enhanced our understanding of measuring embodied carbon, developing an internal embodied carbon database of past and current projects, and what strategies exist to mitigate it. This education has empowered PCS engineers to quantify carbon on our projects for our clients and within the SEI SE 2050 Commitment Program. Externally, we continue to inform our clients about embodied carbon and the critical role structural engineers play in its measurement and reduction.

Sustainability Team Members

Formed in 2021, PCS Structural *Solutions*' internal Sustainability Team has educated and developed resources within the company to help engineers learn, incorporate, and advocate for embodied carbon reductions within our daily work. The PCS Sustainability Team also ensures that the company meets the SE 2050 Commitment Program requirements every year.

Annabel Shephard, Team Leader

Annabel is an in-house educator on embodied carbon reduction strategies and performing life-cycle analysis to quantify project embodied carbon. She has been a member of the SEI Sustainability Committee since 2019 and a member of the SE 2050 Commitment Program since its inception. Annabel currently serves on the SE 2050 Leadership Group as the Program Mechanics Lead.

Brian Phair, Subject Matter Expert

At PCS we generate energy for carbon reduction throughout our industry in the Pacific Northwest. We start at the top by having Brian, our CEO sit on our sustainability committee to ensure support throughout the company and to encourage discussions among the board. We have many clients in our industry asking PCS for guidance as we combine visions and continue on this carbon reduction journey.

Chris Jeseritz, Subject Matter Expert

Chris is passionate about embodied carbon reduction advocacy, quantification, and helping engineers incorporate carbon into their project workflow. He is active within the Carbon Leadership Forum, SEAW Sustainability Committee, SEI Sustainability Committee, and the SE 2050 Commitment Committee.

Jared Plank, Quality Control Liaison

Jared is the Engineering Team Leader at PCS and serves as a resource to ensure collaboration and quality control. He works with the Sustainability Team to connect with associated material or code teams, help set up presentations, give guidance on future white papers, or suggest educational opportunities to help the team or PCS as a whole.

Jaycob Greissl, Member

Jaycob has been involved with creating educational content for external and internal audiences (include the last few ECAPs) as well as gathering sustainability data for multiple PCS projects. As a member since 2022, Jaycob is intrigued by the impact structural engineers can have on creating a more sustainable building environment and incorporating that into the projects he works on.

Madigan Smith, Member

With previous experience in Passive House design, Madigan is interested in advancing energy-efficient building practices and exploring how engineers can drive sustainability through thoughtful design decisions. She aims to expand her knowledge in sustainable design strategies across various building types and develop tools and resources to share with colleagues.

Education

Education Plan

A critical component of moving the building industry toward a net-zero future is providing practicing engineers with an education on the tools and strategies available to them to transform their current building practice into a sustainable one. Because sustainable design is not taught in typical civil engineering university curricula, the responsibility falls on firms to provide this education to their employees. PCS Structural *Solutions* acknowledges this responsibility and provides a diverse curriculum for their in-house designers. This includes multiple in-house presentations, authoring and publishing white papers, providing an accessible library of resources to staff members, and encouraging engineers to seek knowledge beyond the firm.

Educational Opportunities

Throughout the year, the Sustainability Team provides opportunities for staff to educate themselves about different sustainability topics. These educational opportunities occur in internal presentations conducted by Sustainability Team members or by informing staff about webinars by national associations. Internal presentations are given live over Microsoft Teams and are recorded. This creates a library of presentations that can be rewatched by staff who would like to review the content, watched by new staff during their company training, or for staff who were not able to attend the live presentations.

This past year, team members created and presented two internal classes. The first presentation, titled "Structural Sustainability: The Fundamentals, Upcoming Technologies, and Myths", provided a broad review of general and material-specific embodied carbon reduction practices that built upon foundational concepts presented internally during the previous year. The presentation touched on life-cycle assessment tools and looked forward at technologies that may enter the market for our use in the near future. The second presentation, titled "Introduction to Green Rating Systems in the Building Industry", provided a description of the available voluntary green rating systems available to our projects and best practices for selecting and pursuing credits. This year, team members will be presenting on a the changing policy landscape and its relationship with our design practice.

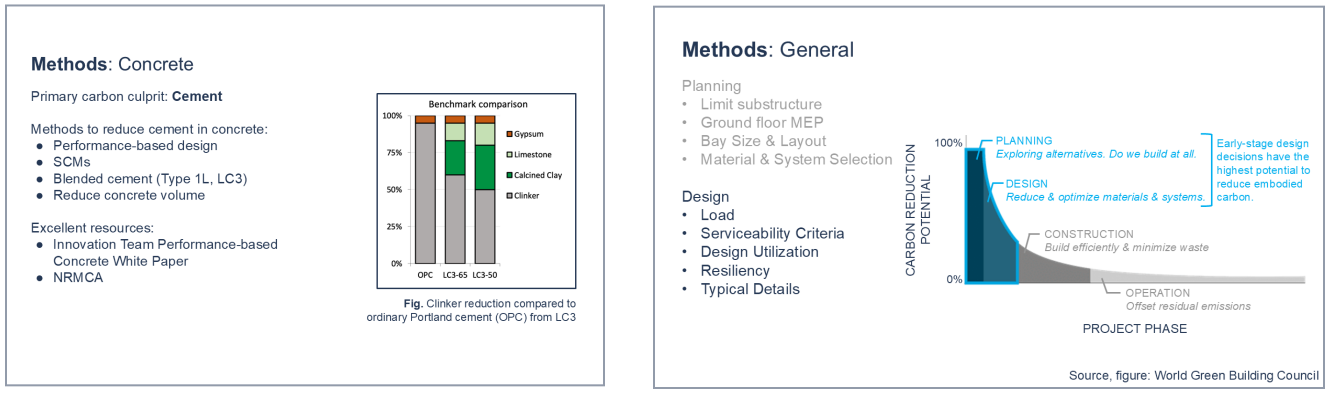


Figure: ***Structural Stustainability: The Fundamentals, Upcoming Technologies, and Myths***

Figure: *Introduction to Green Rating Systems in the Building Industry*

PCS Sustainability Library

The PCS Sustainability Team has created a library on our internal website of presentations, documents, and websites about embodied carbon and sustainability. Staff can go to the page to find helpful resources such as our standard sustainability design practices and guides that help engineers learn and incorporate sustainable design practices in their daily work. This year, team members authored a white paper on concrete embodied carbon titled "Best Practices for Reducing Embodied Carbon in Concrete Mixes" to be published this year (see Reduction section for additional information). This year, team members plan to publish two valuable resources— a fact sheet on passive house accreditation and a second fact sheet on relative policy updates. Both one-pagers will serve as an introduction to the topic or as a quick reference during client conversations.

Education Through Participation

In addition to attending interanal and external presentations, PCS welcomes and encourages its staff to participate in external events and be active on professional committees. Within our company, we have staff involved in professional committees on a varying level of involvement, ranging from attending events to actively participating in national organizations.

External participation allows staff the opportunity to bring back information to the company and advance our understanding and sustainability in structural engineering. Some organizations our employees are a part of include the Carbon Leadership Forum at the University of Washington, the Structural Engineers Association of Washington's Sustainability Committee, the Structural Engineering Institute's (SEI) Sustainability Committee, and the SEI Structural Engineering 2050 Commitment Program.

ECAP Educational Commitments and Goals

Commitment 1: Provide a narrative of how the Embodied Carbon Reduction Champion will engage in embodied carbon reduction at each office.

- Status at the time of ECAP Publication: **Complete**

  The embodied carbon reduction champion will engage and aid with embodied carbon reductions at each PCS office through members of the company's internal sustainability team. At least one team member will represent each office and learn about new developments and studies in embodied carbon reduction through the team's meetings, discussions, and research. The team members will share knowledge obtained from the sustainability team with each other employees at each office. For complex or difficult inquiries about reducing embodied carbon, a team member can bring the question to the entire group to decide on the best answer.

Commitment 2: Present one webinar focused on embodied carbon available to all PCS employees.

- Status at the time of ECAP Publication: **Complete**

PCS's internal sustainability team presented two embodied carbon presentations: "Green Rating Systems in the Building Industry" and "Structural Sustainability: The Fundamentals, Upcoming Technologies, and Myths." Additionally, we had presentations and webinars on the new ACI 323-24 code on low-carbon concrete, and a Febreeka representative discussed structural thermal bridging strategies and products.

Commitment 3: Incorporate embodied carbon education in your onboarding process for all new engineers.

- Status at time of ECAP Publication: **In progress**

  Currently, PCS has had an informal introduction to embodied carbon in structural design. We are still brainstorming ways to incorporate embodied carbon education into the onboarding process for newly hired engineers. We intend to have a process in place in time for our next round of new hires this summer.

Commitment 4: Initiate an embodied carbon interest group within your firm and outline their goals. This group may more broadly address sustainability, but they must include embodied carbon.

- Status at time of ECAP Publication: **Complete**

  PCS has created a sustainability team comprising members from each office. The team's mission is to share information company-wide on all aspects of structural solutions for buildings by staying current on industry changes, maintaining up-to-date engineering resources, and advising on company design standards. The team's efforts included embodied carbon and broad sustainability within our offices' processes within engineering and general office practices.

ECAP Educational Commitments and Goals (cont.)

Commitment 5: Create an Embodied Carbon digital resource wiki and/or forum on your firm's internal website for staff to create, share, and discuss Embodied Carbon educational resources.

- Status at time of ECAP Publication: **Complete**

  PCS has created an internal website containing valuable documents, resources, and links for structural engineers. The website and resources are reviewed and updated annually.

Commitment 6: Engage with a CLF Regional Hub.

- Status at time of ECAP Publication: **Ongoing**

  PCS employees actively attend and interact with the local Carbon Leadership Hub.

Reporting

Reporting Plan

For the SE 2050 Database, PCS Structural *Solutions* follows the LCA methodology provided in the latest version of ISO 14040 and ISO 14044. At a minimum, the LCA scope analyzed for all projects is Cradle to Grave (EN 15978 life-cycle phases A to C). We publish results with both biogenic carbon included and excluded.

PCS calculates embodied carbon for structural materials using the Autodesk Revit application, Tally. This application was selected since most EN 15978 LCA phases A-D are included in the analysis, material quantities can be extracted directly from Revit during different design phases, and it allows PCS to collaborate with our clients using Tally. The database in Tally offers industry-wide and manufacturer-specific Environmental Product Declarations (EPDs). The US Life Cycle Inventory Database, GaBi, and ASTM EPDs provide the life-cycle inventory (LCI)/LCA data in Tally. PCS has created an internal Tally User Guide to standardize how our staff performs a life-cycle analysis.

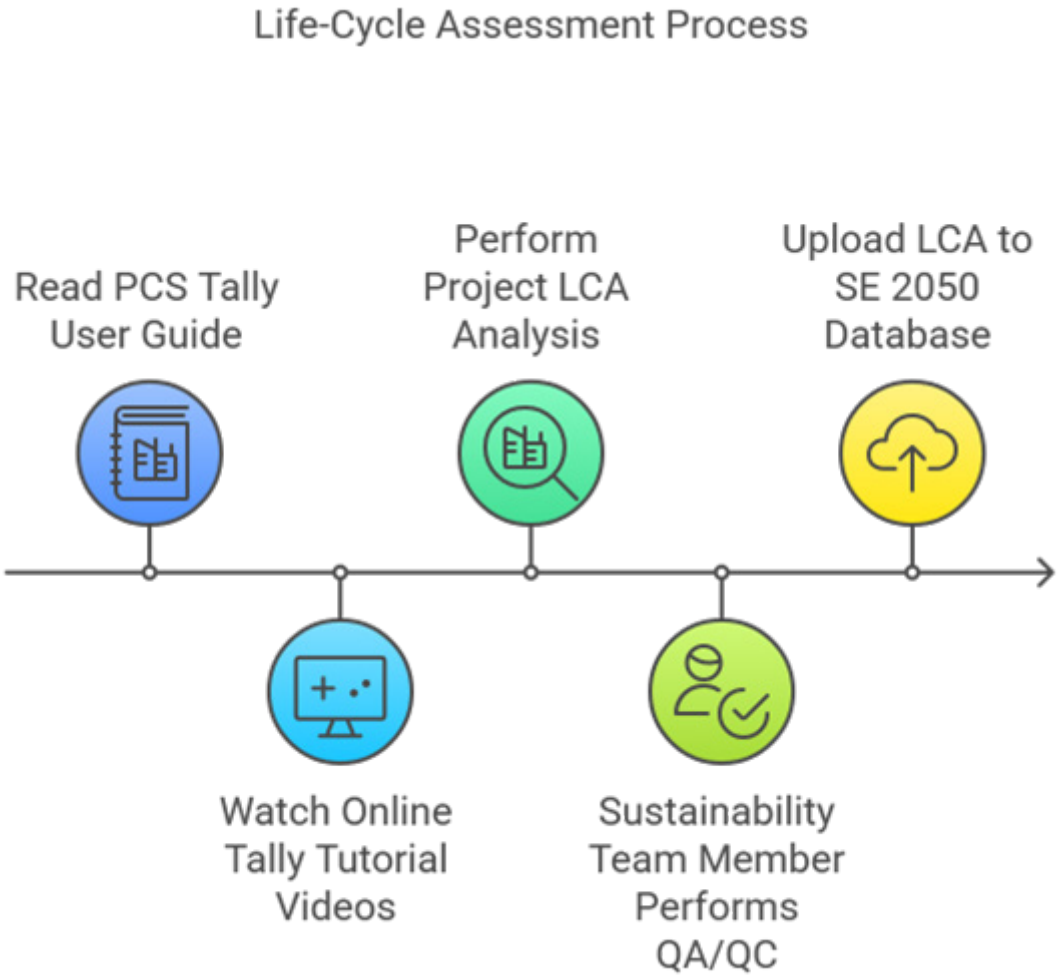


Figure: PCS Structural *Solutions*' internal process for conducting a life-cycle assessment.

Material Quantities

Material quantities can be extracted through the Revit model using Tally during any project phase. We plan to extract these quantities during the key milestone phases of the project, including Design Development, Permit, and Construction Documents. During construction, we will transition to material quantities supplied by the contractor. PCS's typical Embodied Carbon Workflow is shown in the Embodied Carbon Reduction Strategies section. Below is the data workflow during construction.

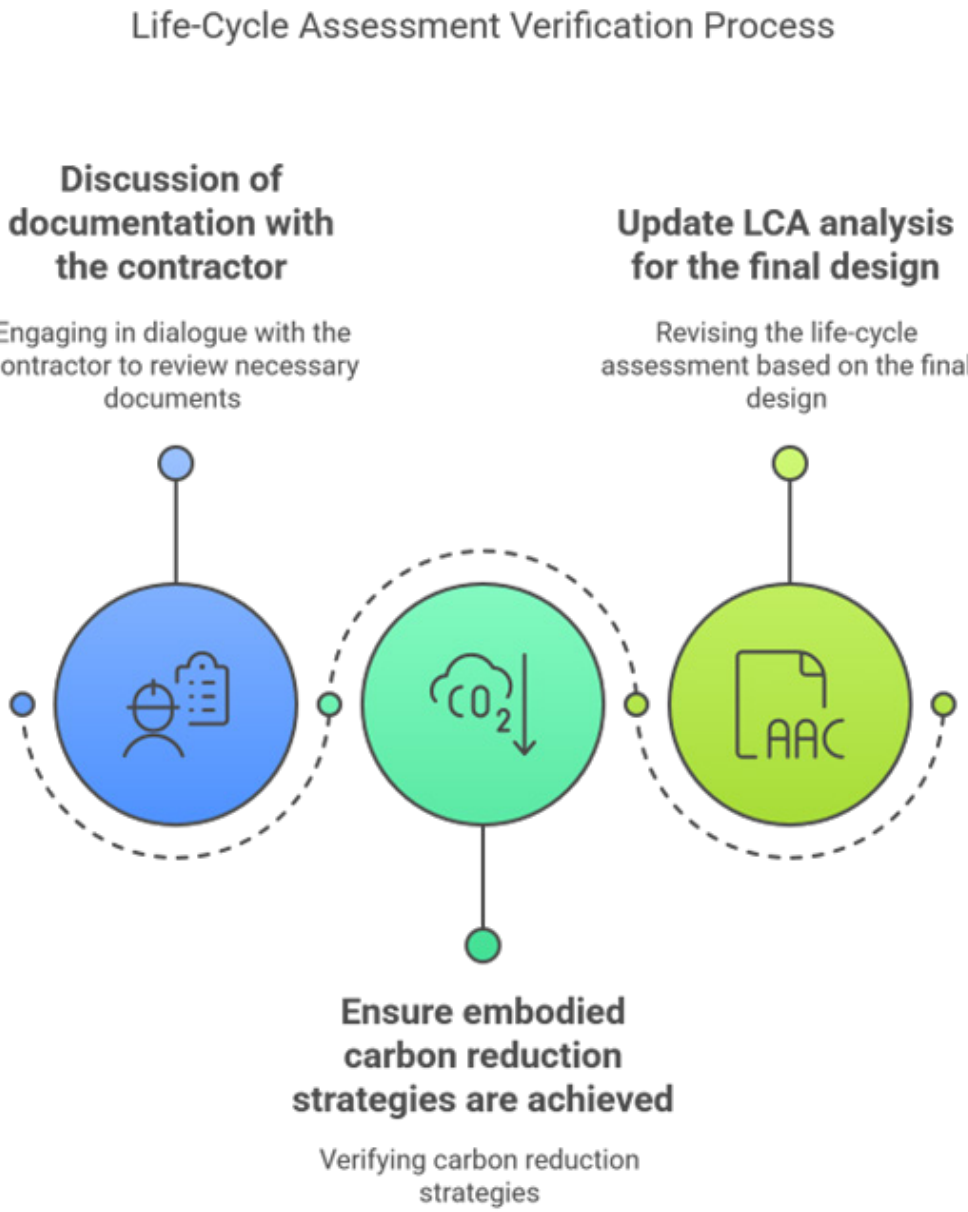


Figure: PCS Structural *Solutions*' construction process for verifying life-cycle assessment results during and after construction.

PCS Database

PCS created an internal database for measuring and comparing concrete-specific environmental product declarations (EPDs) and multiple projects' structural upfront (LCA Stages A1– A3) and life (A – C) embodied carbon.

This database has helped us track the embodied carbon values for various concrete mix designs we have used on past projects from multiple regions and concrete suppliers. The data helps us recommend global warming potential limits or reduction targets for different types of concrete mixes used in future projects.

Additionally, our internal database automatically calculates the upfront embodied carbon (A1 – A3) for any project uploaded to the database. This automation allowed us to develop an internal database of past and current projects quickly, but it comes with the caveat of multiple built-in assumptions. Therefore, the automated upfront embodied carbon numbers are intended to provide only a rough order of magnitude of potential upfront embodied carbon that we can utilize in schematic design when considering multiple building material types.

The database also contains the results of the projects we've conducted a life-cycle assessment on. This allows us to compare and track our embodied carbon internally as we work to reduce our structure's embodied carbon. Each module within the database can be printed out and shared with clients.

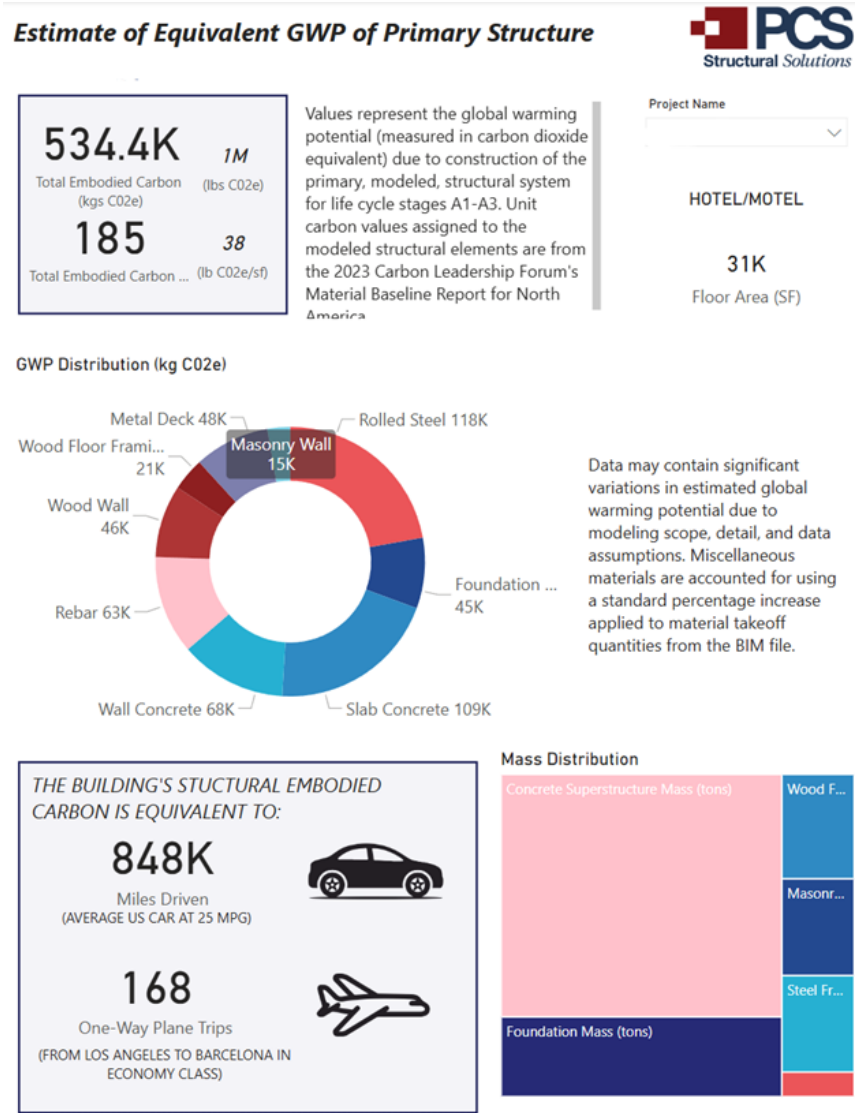


Figure: PCS Structural *Solutions* Database: Project Upfront GWP Data Sheet

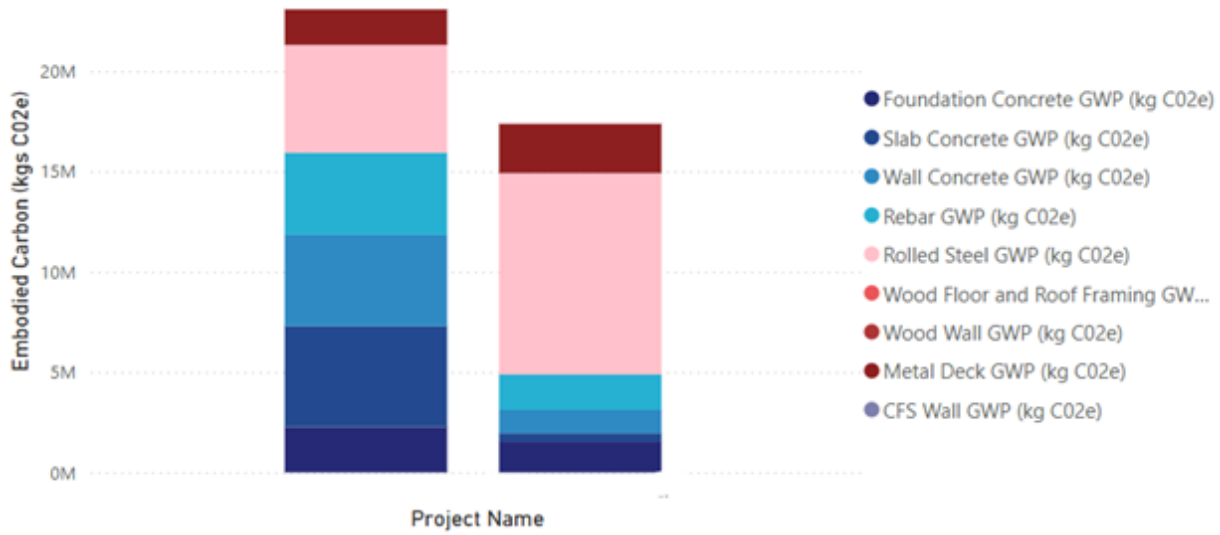
Comparison of Equivalent GWP Estimates

Project Name	Embodied Carbon Total (kgs C02e)	Embodied Carbon Intensity (kg C02e/m2)
	25634119	290.73
	21450667	291.41

Project Name

Multiple selections

Material Comparison of Equivalent GWP



Total Embodied Carbon Intensity (kg C02e/m2)

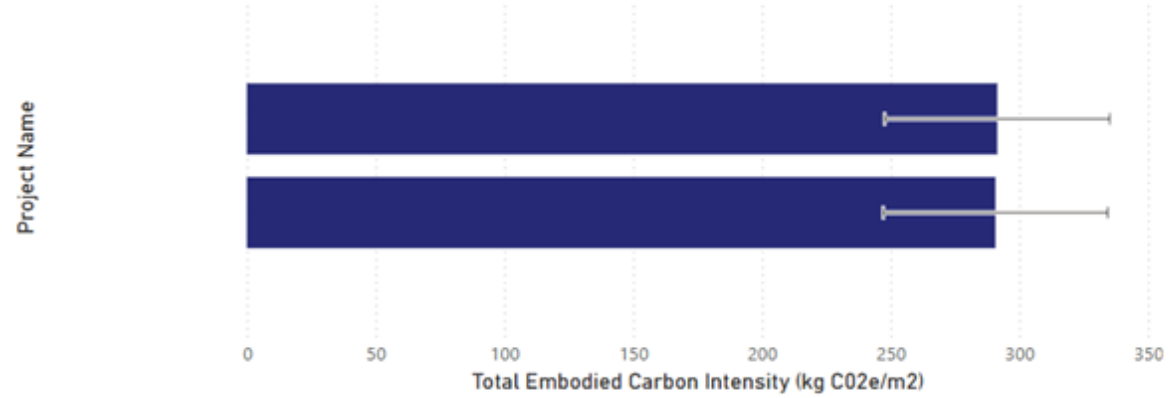


Figure: PCS Structural *Solutions* Database: Project Comparision Data Sheet

ECAP Reporting Commitments & Goals

Commitment 1: Submit an annual minimum of (2) projects per U.S. structural office but need not exceed (5) total projects for the firm to the SE 2050 Database.

- Over the past year, PCS submitted the program requirement of five projects to the SE 2050 database.
- Status at time of ECAP Publication: **Complete**

  PCS has completed LCAs for multiple projects in the healthcare, hospitality, high end residential, and K-12 sectors. Additional LCAs are currently in progress for projects throughout the Pacific Northwest, with the goal of covering a wider range of project types and materials.

Commitment 2: Compare the embodied carbon emissions from multiple projects across your firm. Analyze and document what data or pieces of information are most important and communicate the findings to your firm.

- Status at time of ECAP Publication: **Complete**

  PCS has developed an internal database to compare and contrast the multiple projects embodied carbon. The database includes information on the estimated upfront embodied carbon (A1-A3), concrete GWP information, and project's LCA EC results.

Figure: PCS Structural *Solutions* Database: Project Comparision Data Sheet

Embodied Carbon Reduction Strategies

Reduction Plan

Structural engineers have the potential to reduced embodied carbon within the built environment by implementing embodied carbon reduction strategies. Selecting sustainable building materials, increasing the efficiency of structural design, and collaborating with architects and material providers to quantify embodied carbon are just a few ways PCS is working towards net-zero embodied carbon by 2050. PCS will continue developing practical, sustainable solutions to meet client and owner needs as we implement lessons learned from projects of the past and present.

Carbon Reduction for Concrete

Concrete is the most consumed building material in the world, and PCS is committed to developing strategies to reduce embodied carbon associated with the production of ingredients used in concrete mix designs. Internal white papers were written to outline effective strategies that can be implemented on all PCS projects utilizing concrete. These include replacing traditional cement with Type 1L cement and implementing performance-based concrete specifications to allow for greater collaboration with concrete producers to meet embodied carbon reduction goals. This year the team reviewed and revised our template general notes and specifications to optimize our company standards to having the default practice be the most sustainable practice where possible.

Timber Transparency Guide

Wood is a common material used in the Pacific Northwest in part because of the long history of timber production and harvesting. It's a building material frequently characterized as inherently sustainable regardless of design methodology or sourcing practice. PCS Structural *Solutions* designs with timber as we recognize the benefit of the material structurally and the potential benefit of the material sustainably. We want to design with timber harvested from forests that practice responsible forest stewardship and conservation, for the benefit of meeting our embodied carbon reduction standards and for the health of our communities water, soil, and habitat. This year, our team aims to collaborate with local building design professionals to develop a timber transparency guide to allow us, at all project scales, to follow a template of sustainable timber sourcing and specify wood from climate-smart forests.

ECAP Reduction Commitments & Goals

Commitment 1: Develop and implement a workflow that makes it easier to make early design decisions based on embodied carbon.

- Status at time of ECAP Publication: **Complete**

  PCS has developed a workflow to outline the embodied carbon considerations that should be taken at each stage of the design process.

Commitment 2: Incorporate biogenic materials on at least one project annually.

- Status at time of ECAP Publication: **Ongoing**

  As a Pacific Northwest firm, incorporating biogenic materials in our projects is a natural fit. The timber industry played a significant role in the region's history and continues to innovate and evolve. Using wood products from local suppliers will help reduce the embodied carbon associated with transporting the material and support our local economy.

  The incorporation of biogenic materials into a project will typically lead to a reduction in the embodied carbon. Carbon savings come from several sources. It takes less energy to process the raw wood into building elements compared to the equivalent steel or concrete member. A wood element will also generally weigh less than the equivalent steel or concrete member, which results in lower emissions from transporting the material to the construction site.

  Another advantage of biogenic materials is they provide carbon storage. During the tree's growth, it absorbs carbon dioxide from the atmosphere. It will store this carbon until the wood either burns or decays. Since this carbon is eventually released, it may not be considered in the LCA. However, the delay in the release of carbon is valuable. Carbon present in the atmosphere currently will have a much more significant impact on climate change than carbon released years into the future.

Commitment 3: Participate in a LEED®, ILFI Zero Carbon, or similar project design charrette and speak to potential design considerations impacting embodied carbon.

- Status at time of ECAP Publication: **Complete**

  PCS has helped and provided clients with embodied carbon reduction strategies for projects seeking LEED or ILFI Zero Carbon certification. These strategies have helped the team reduce embodied carbon to help achieve the desired credits/certification.

ECAP Reduction Commitments & Goals (cont.)

Commitment 4: Integrate embodied carbon mitigation strategies in your General Notes.

- Status at time of ECAP Publication: **Complete**

  PCS has implemented Type 1L cement into all projects' general notes. This update allows concrete providers to use Type 1L cement in all concrete mixes. Type 1L is a blended cement that reduces the amount of cement in the concrete mix by the addition of limestone. Since cement is the largest contributor to the global warming potential of concrete, reducing cement will directly reduce the embodied carbon associated with the concrete mix.

  We also have begun a slow transition to performance-based concrete specifications on large projects. We have completed updating our master general notes to include embodied carbon reduction strategies and guidelines as an engineer is beginning to set up a project.

Commitment 5: Publish a document outlining best practices for reducing cement in concrete mixes.

- Status at time of ECAP Publication: **Complete**

  PCS has internally published a white paper discussing different ways structural engineers can reduce cement content within concrete mixes. Since cement is the largest contributor to the global warming potential of concrete, reducing cement will directly reduce the embodied carbon associated with the concrete mix. We have also published a white paper on performance-based concrete specifications with provided examples.

Advocacy

Knowledge Sharing Plan

PCS Structural *Solutions* recognizes the vital role that structural engineers play in addressing climate change. We have the tools necessary to track and measure embodied carbon, enabling us to quantify our carbon reduction strategies. However, achieving our goals cannot be done by one company alone. A key component of our mission is to create awareness and amplify the efforts of organizations like SEI SE 2050.

The SEI SE 2050 Commitment community offers a fantastic opportunity for growth and learning. Structural engineers bring a unique perspective to both the world and the built environment. It's essential for PCS and others in the field to actively provide solutions and offer sound judgment in advocating for embodied carbon reductions to clients, material suppliers, and peers.

Advocacy at PCS Structural Solutions

PCS has given multiple presentations to clients and peers on embodied carbon in the structural engineering profession. Events and conferences we've presented at include Portland's Sustainability Building Week, A4LE Washington Chapter 2024 Conference, and SEICon24, to name a few. These presentations allow us to share lessons we've learned through our structural design practices and being an active member of the SE 2050 Commitment Program.

Our advocacy efforts will be realized through engagement with external organizations, participation in code and legislation hearings related to embodied carbon, and by including this focus in the marketing materials and project proposals we provide to clients.

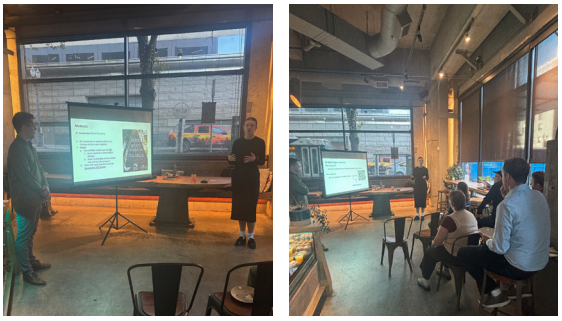


Figure: Brad & Annabel's Sustainability Building Week Presentation in Portland, OR

Figure: Alex Lege's Presentation at A4LE in Spokane, WA

Figure: Annabel's Presentation at SEICon24 in San Antonio, TX

Figure: Legislation and Code Hearings PCS has participated in

Figure: Organizations PCS is actively involved in

ECAP Advocacy Commitments & Goals

Requirement 1: Share your commitment to SE 2050 on your company website.

- Status at time of ECAP Publication: **Complete**

Requirement 2: Describe the value of SEI SE 2050 to clients. How can we collaborate to reduce embodied carbon? At your option, attach any associated marketing materials.

- Status at time of ECAP Publication: **Complete**

  As a signatory of the SE 2050 Commitment Program, PCS is part of a large movement to quantify, measure, and reduce embodied carbon in any type of project and project budget. Through the program's resources, access to the SE 2050 Database, and participation in signatory calls we have gained vast knowledge on embodied carbon reduction strategies and worked on measuring our projects' embodied carbon. This value is communicated to our clients through a marketing qualifications page focusing on our commitment to the SEI SE 2050 and other sustainability efforts included in a project proposal and interview process.

Requirement 3: Give an external presentation on embodied carbon, demonstrating project success and lessons learned. Get connected at a CLF regional hub near you.

- Status at time of ECAP Publication: **Complete**

  Multiple PCS employees have given numerous external presentations to clients and industry organizations on embodied carbon and how structural engineers play a vital role in its measurement and reduction.

  PCS is actively involved with the Carbon Leadership Forum at the University of Washington. We attend local events and have presented during the June 2024 Sponsors Call on our internal embodied carbon database.

Requirement 4: Engage with local, state, and federal governments to communicate the importance of low-embodied carbon procurement and construction policies.

- Status at time of ECAP Publication: **Complete**

  PCS has attended and participated in several hearings discussing legislation and building code amendments in Washington State regarding carbon reduction in the construction industry, including the Washington State Buy Clean and Buy Fair bill that will go into effect on July 1, 2025 and the Washington State Reducing Embodied Carbon Emissions of Buildings and Building Materials.

  PCS will continue participating in public hearings to communicate the importance of carbon reduction policies.

Lessons Learned

Reduction Targets for Embodied Carbon

When selecting embodied carbon reductions, whether for structural material(s) or the entire project, finding the right balance between pushing the industry toward producing less carbon-intensive materials and maintaining the status quo was a learning experience in 2024.

For structural materials, our embodied carbon baselines are typically established using the Carbon Leadership Forum's Material Baselines for North America Report or the material's industry average environmental product declaration (EPD). The embodied carbon reduction percentage from the baseline is then selected based on project type, project goals, and EPD internal (see Reporting Plan section) and external (The Embodied Carbon in Construction Calculation, EC3) database results.

For projects with a goal of embodied carbon reduction, we select a reduction percentage that correlates to approximately the top 20 percent of similar concrete mix designs within the project's region or incentivize lower-carbon concrete during the bidding process and selection. This has produced mix results, with some projects reaching and surpassing our reduction goals and others receiving push-back. In other projects, we've had success reducing the embodied carbon when compared to the baseline; however, these regions' average structural embodied carbon is already lower than the benchmarks and is, therefore, not pushing the industry toward innovation and higher reduction of embodied carbon.

When incorporating embodied carbon reductions into a project, we've learned

1. Push the envelope on reductions as much as possible; however, requiring reductions or even embodied carbon measurements helps the industry become more knowledgeable about carbon.
2. Allow flexibility with how the project and contractor can reach target reductions. This can be a global embodied carbon goal of defined materials and an embodied carbon weighted average for each material.

Estimating Embodied Carbon in Early Design Phases

The earlier embodied carbon is discussed and considered in the design process, the more opportunities there are for reduction. However, structural systems are not fully developed or understood in the early design phases due to evolving design aesthetics, programming requirements, and budget constraints. Therefore, a key, similar to the structural design, is to be nimble and quick when estimating embodied carbon.

With PCS's internal database, we have been able to rapidly build a database of past and current projects that provide us with a rough order of embodied carbon magnitude for multiple project layouts and material types. This starting point allows us to determine which materials and layouts contribute to lower embodied carbon per square foot and what other efficiencies can be realized through the design. Previously, we created a simple floor framing bay of gravity-only elements to determine the embodied carbon. However, this could be time-consuming and project-restrictive.

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