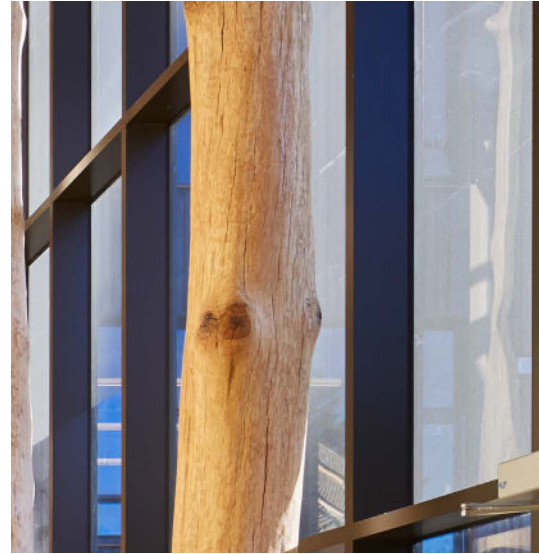




*Connected Teams.
Bold Solutions.*



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

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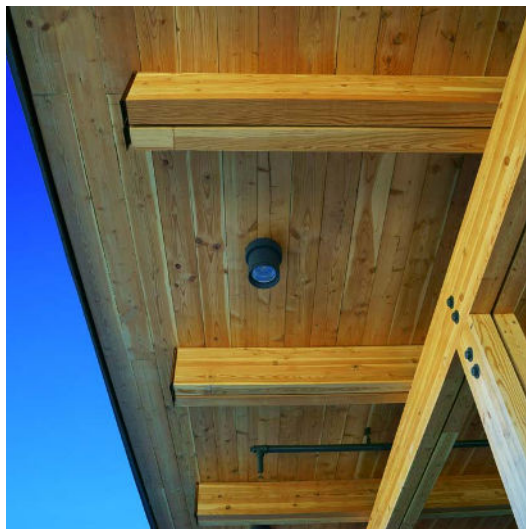
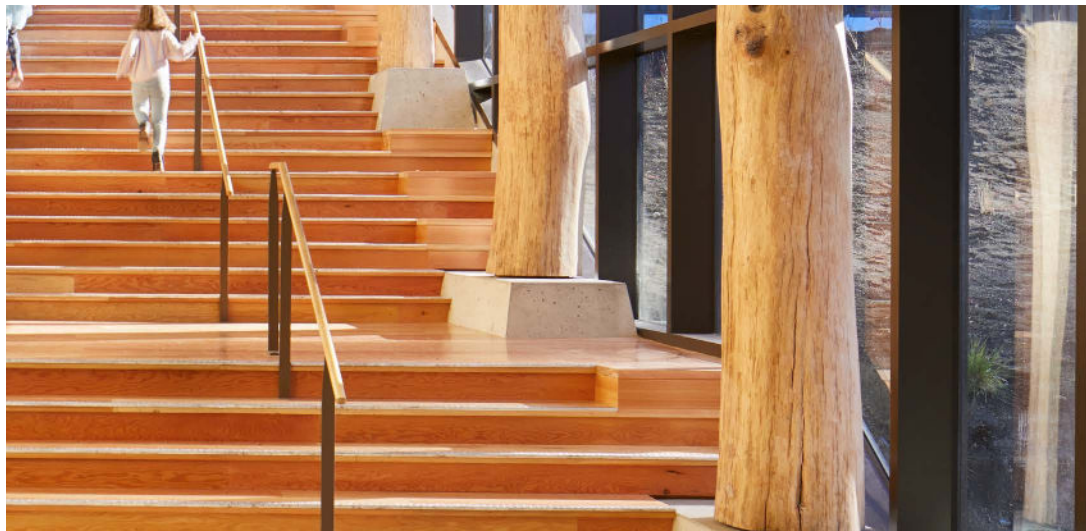




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A photograph of a curved, modern architectural structure made of light-colored wooden slats, possibly a staircase or a walkway, with a dark metal railing in the background.

Introduction

As a single-discipline structural engineering firm, PCS Structural *Solutions* understands our structural systems' impact on the environment — both now and for future generations. We recognize the importance of measuring and tracking structural embodied carbon at a national level, setting benchmarks, and working towards future carbon reduction levels. By offering sustainable project solutions, educating staff and clients, and actively participating in national programs, PCS Structural *Solutions* will join other structural engineering firms around North America to progress towards our collective goal of net-zero embodied carbon by 2050.

In PCS Structural *Solutions*' 2022 Embodied Carbon Action Plan (ECAP), we outline our internal and external pledges for 2022 and what we learned from our previous year of commitment. Our pledges will be the launching point for PCS to further efforts toward net-zero embodied carbon by 2050. For the first couple of years, PCS's ECAP will heavily focus on educating our staff and clients on embodied carbon. Internally, we will elevate our knowledge about embodied carbon, how we measure it, and what strategies exist to reduce it. This education will allow PCS to adequately measure carbon on our projects for our clients and the SEI SE 2050 Commitment Program. Externally, we will teach our clients what embodied carbon is and how structural engineers play a pivotal role in its measurement and reduction. This will help solidify structural engineers' critical role in sustainability and mitigating embodied carbon within the architecture, engineering, and construction community.

A solid beginning is crucial as PCS Structural *Solutions* embarks on the journey towards net-zero embodied carbon by 2050. Along the path, PCS will share accomplishments and lessons learned regarding education, measurement, reduction strategies, and advocacy to aid in developing future ECAPs.

Lessons Learned

Materials Sourcing

PCS is working hard to reduce the environmental impact of all our structural materials specified in a project. Currently, our focus is on concrete since multiple strategies are available to structural engineers that reduce the embodied carbon of our mixes and typically do not provide any cost increases to the client. Some of the strategies PCS has explored include Type 1L cement, performance-based concrete specifications, mixes using large quantities of supplementary cement materials (SCMs), and tracking emerging technologies regarding carbon injection. However, due to recent supply chain and production issues, we have experienced problems obtaining SCMs and are beginning to see our Type 1L cement shipped from Taiwan instead of being produced within the region. We have been working closely with different concrete suppliers on alternative SCMs and strategies that help us achieve our embodied carbon reduction goals for concrete.

Client Communication/Embodied Carbon Reduction Advocacy

PCS has created documents that are shared with clients to summarize and illustrate different strategies to help reduce embodied carbon. One of these is a list of carbon reduction strategies that can be considered for several structural systems and materials, allowing clients to make informed and sustainable decisions from the beginning of the project. This list has been well received by clients and begins a conversation on embodied carbon reduction and what strategies can be implemented on the project.

PCS advocates for considering and measuring a structural system's embodied carbon as early as possible in the design process. By selecting the appropriate structural system early in the design phase, meaningful reduction strategies can be used as the project progresses through the design phases into the construction phase. Whenever a project is looking to perform a whole building life-cycle assessment (LCA), we advocate that PCS measures the embodied carbon of the structural system.

With these tactics, we have provided embodied carbon reduction with little to no increase in the project's budget and our design fees. We hope to implement these strategies with more consultants.

Life-Cycle Analysis (LCA)

PCS has learned how complex an LCA can be when using a structural building information model (BIM). This complexity comes from the BIM's level of development, knowledge of the building's structure, and LCA process. Through our first year, with a small sample size of projects, we found that engineers knowledgeable about the structural system over the LCA process tended to complete an LCA quicker than engineers familiar with the LCA process and not the project. In addition to the introduction tutorial, we provide engineers conducting their first LCA, we have authored an internal guide that walks engineers through the LCA process, assigning parameters for different structural materials, and other useful tips and tricks.

Education

Education Plan

PCS Structural *Solutions* understands that the key to making significant and sustained reductions in structural embodied carbon is providing our staff with the necessary education. Sustainable design is not taught in typical civil engineering university curriculum. PCS acknowledges that we must start with the basics and work towards advanced and nuanced topics about embodied carbon reduction strategies and measurements. PCS's internal education program will begin by introducing our staff to the subject of sustainability in structural engineering. Over time the program will continue to develop our staff's knowledge and skills to a practicing level. As the understanding and science of sustainability evolve, the program will keep staff updated with the latest knowledge and practices. Through the robust and continuing educational program, PCS can equip our employees with the necessary expertise and tools in sustainability to help achieve our company's and client's goals to reduce embodied carbon.

ECAP Educational Commitments & Goals

Commitment 1: Distribute ECAP within PCS upon publishing.

- Status at the time of ECAP Publication: **In progress**
 - » PCS's 2022 ECAP will be distributed to all employees upon publication.

Commitment 2: Present (1) webinar focused on embodied carbon available to all PCS employees.

- Status at the time of ECAP Publication: **Complete**
 - » PCS's internal sustainability team developed a presentation introducing PCS employees to LCA with the tool Tally. The presentation "SUS 201: A Deep Dive into Tally" was presented to the entire company on April 22, 2022. The presentation defined key terms, described the significance of LCA, listed common LCA tools, and discussed the appropriate application and methodology of Tally within the company. See Figure 1 in the Appendix for a slide taken from the presentation.

Commitment 3: Have one firm representative attend quarterly external educational programs provided by SE 2050, the Carbon Leadership Forum, and/or local Structural Engineering Association's Sustainability Committee.

- Status at time of ECAP Publication: **Ongoing**
 - » Currently, PCS has a couple of employees attending and actively involved with external educational programs provided by SEI SE 2050, the SEI Sustainability Committee, the Carbon Leadership Forum, and the Structural Engineering Association's Sustainability Committee.

ECAP Educational Commitments and Goals, continued

Commitment 4: Provide a narrative of how the Embodied Carbon Reduction Champion will engage embodied carbon reduction at each office (intended for multi-office firms).

- Status at 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 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 5 (from 2021 ECAP): Present the document "How to Calculate Embodied Carbon" to PCS's internal sustainability team.

- Status at time of ECAP Publication: **Complete**
 - » The document "How to Calculate Embodied Carbon" was made available to all PCS employees and was presented at one of PCS's internal sustainability team meetings.

Commitment 6 (from 2021 ECAP): Attend a presentation or demo of an LCA-based tool used to calculate embodied carbon.

- Status at time of ECAP Publication: **Complete**
 - » The internal sustainability team has educated a select few individuals from each office through available literature, attending presentations/demos, and hands-on training to learn our company's LCA program of choice, Tally. PCS will continue to teach individuals as needed how to calculate embodied carbon.

Reporting

Reporting Plan

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 reports internally with both biogenic carbon included and excluded but only report data excluding biogenic carbon to the SE 2050 database.

PCS calculates embodied carbon for structural materials using the Autodesk Revit application, Tally. This application was selected since most of the 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 life-cycle inventory (LCI)/LCA data in Tally is provided by the US Life Cycle Inventory Database, GaBi, and ASTM EPDs.

Material quantities can be extracted through the Revit model using Tally during any phase of a project. We plan to extract these quantities during the key milestone phases of the project, including Schematic Design, Design Development, and Permit. During construction, we will transition to material quantities supplied by the contractor.

ECAP Reporting Commitments & Goals

Commitment 1 (from 2021 ECAP): Describe the internal training for embodied carbon measurement you provided or will provide.

- Status at time of ECAP Publication: **Complete**
 - » PCS has offered an internal class covering the basics of embodied carbon and LCA, as well as published a user guide for Tally and other embodied carbon measurement tools that is available to all internal staff members.

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

- Last year PCS submitted the minimum program requirement of five projects to the SE 2050 database.
- Status at time of ECAP Publication: **In progress**
 - » PCS has completed LCAs for multiple projects in the healthcare, 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.

Embodied Carbon Reduction Strategies

Reduction Strategy

With few data points currently available to quantify embodied carbon reduction, many of the lessons learned have come from the implementation of carbon reduction practices. Many clients have been willing to explore ways to incorporate sustainable practices into project designs; however, economic limitations have slowed their adoption. PCS will continue developing practical, sustainable solutions to meet client and owner needs while achieving carbon reduction goals.

Adjusting specifications for concrete mixes has successfully reduced embodied carbon over a wide range of project types and sizes. Type 1L cement has been a widely accepted substitute for traditional cement, which is much more carbon-intensive to produce. PCS will incorporate performance-based concrete specifications into more projects, providing even more opportunities for manufacturers to reduce the quantities of high-carbon concrete ingredients.

ECAP Reduction Commitments & Goals

Commitment 1: Set an Embodied Carbon reduction goal for the coming year.

- Status at time of ECAP Publication: **Complete**
 - » PCS is currently developing a benchmark for embodied carbon reduction by conducting LCAs on a larger number of projects/project types. This is being developed internally due to the lack of sufficient, up-to-date resources available to provide embodied carbon reduction benchmarks.

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

- Status at time of ECAP Publication: **In progress**
 - » 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 it continues to innovate and evolve. Using wood products from local suppliers will help reduce the embodied carbon associated with the transportation of 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 emissions 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.

ECAP Reduction Commitments & Goals, continued

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.

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 project's 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.

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

- Status at time of ECAP Publication: **In progress**
 - » Since concrete is used on almost every project and its embodied carbon can be easily reduced with little to no cost increase, PCS is working on a 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.

Advocacy

Knowledge Sharing Narrative

PCS Structural Solutions recognizes that structural engineers are vital in addressing climate change. We have the tools to track and measure embodied carbon which allows us to quantify our carbon reduction strategies. However, this work cannot be done by one company alone. A key component to achieving our goals is creating awareness and amplifying the work done by SEI SE 2050 and similar organizations. The SEI SE 2050 Commitment community is a fantastic place to grow and learn. As structural engineers, we bring a unique perspective to the world and built environment. PCS must take its place in providing solutions and sound judgment in advocating for embodied carbon reductions to our clients, material suppliers, and peers. Our advocacy will be accomplished through involvement with outside organizations, outreach through media outlets, and the marketing material/project proposals PCS provides clients.

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 drive adoption? At your option, attach any associated marketing materials.

- Status at time of ECAP Publication: **Complete**
 - » PCS sees the most significant value to clients of the SEI SE 2050 Commitment Program as the ability to inform project decisions in early conceptual and schematic design phases. By establishing industry benchmarks and leveraging the national database, PCS can help design partners evaluate the impact of structural system options on the embodied carbon associated with the project.
 - » PCS has created a qualifications page, which focuses on our commitment to SEI SE 2050 and other sustainability efforts that are included in project proposals. See Figure 2 in the Appendix.

Requirement 3: Share education opportunities with clients.

- Status at time of ECAP Publication: **Complete**
 - » PCS has worked with several clients interested in the lessons we have learned on projects and what internal strategies and documents we have that empower structural engineers to make meaningful reductions in the structural system's embodied carbon.

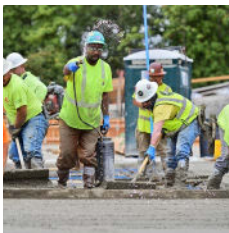
Appendix



Figures above: PCS's Internal Presentation on Tally titled "SUS 201 – A Deep Dive into Tally"



SEI SE 2050 works to educate, engage and report the impacts of the built environment and its associated embodied carbon. The Goal—to achieve net zero embodied carbon by 2050.



Sustainability at PCS

PCS is an official supporter of the **Structural Engineering Institute's Structural Engineers 2050 Challenge (SEI SE 2050)** initiative to measure progress toward carbon neutrality in buildings by 2050. Endorsed by SEI in late 2019, SEI SE 2050 will challenge structural engineers to meet embodied carbon benchmarks and increasingly higher reduction targets in a race towards the most efficient building as we approach the year 2050.

PCS is an early adopter of the **Embodied Carbon in Construction Calculator (EC3) Tool**, which provides A/E/C teams, owners, and policy makers with a platform to compare and reduce the carbon footprint of construction materials.

A core team of our engineers is training to become proficient with the EC3 tool and the life-cycle assessment (LCA) tool, Tally, to help teach its use throughout our firm. These tools will help inform us of our designs' carbon impact on the environment, and the data will be shared and used for the SEI SE 2050 challenge to develop the A/E/C industry's education and movement toward carbon neutrality.

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