SE 2050 Embodied Carbon ACTION PLAN

kpff

2024

01

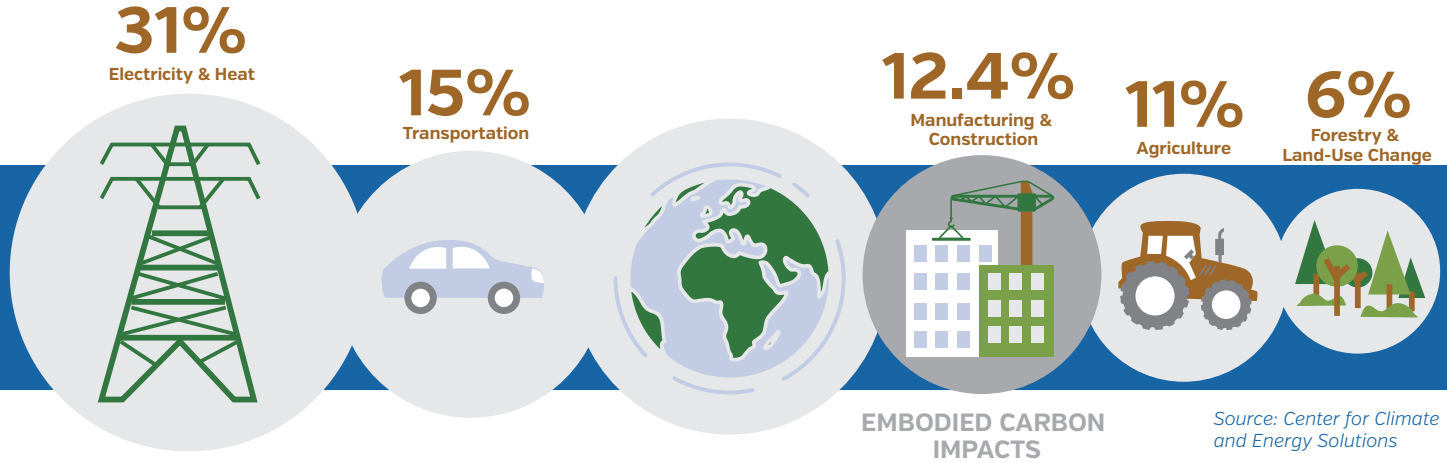
Introduction

KPFF recognizes and supports the SE 2050 Challenge vision statement that “all structural engineers shall understand, reduce, and ultimately eliminate embodied carbon in their projects by 2050.” As the SEI Board of Governors stated in their endorsement of the SE 2050 Challenge, we also “recognize the need for coordinated action across our profession to achieve the globally stated goal of net zero carbon by 2050.”

KPFF joined the SE 2050 Commitment in 2021, and we update our Embodied Carbon Action Plan (ECAP) annually to show what we have been doing during the past year and what our plans are for the next year.

The vision of SE 2050 directly aligns with the core values that have guided our organization successfully over the last 60 years. These values are relationships, trust, passion, excellence, and stability. The vision of the future contained within the SE 2050 program is one of **relationships**, with our community locally and globally. It is a vision of providing **stability** and maintaining **trust** with future generations, recognizing that we play an essential role in reducing the embodied carbon (EC) that will impact future generations for the next 26 years and beyond. It exemplifies the **passion** we have as engineers, to meet the challenges of today with new ideas and solutions. It requires the leadership and **excellence** to find and implement new carbon strategies that are truly effective and impactful.

Globally, the primary sources of greenhouse gas emissions are:



Source: Center for Climate and Energy Solutions

Cover image: Courtesy of City of Sunnyvale, CA

Project Highlight >>

Sunnyvale City Hall

Sunnyvale, CA

The Sunnyvale Civic Center project includes site improvements, renovation of the Public Safety building, and construction of a new Emergency Operations Center and City Hall.

The City of Sunnyvale pursued lofty **sustainability goals** throughout the re-imagining of their Civic campus. The site design embraced the natural environment, preserving redwood groves and relocating ancient camphor trees where needed. A felled redwood was used to create beautiful furniture featured in the main addition - the new 119,000 GSF City Hall building.

The new City Hall is the first all-electric, **net-zero operational energy** city hall built to LEED platinum certification. Beyond the LEED checklist, the design team pursued bold sustainability strategies such as a **low-carbon timber curtain wall** and soaring photovoltaic array providing on site energy generation and shading the structure below. Extensive use of biophilic wood interior finishes, curving wood clad central stair, and a building layout that embraces views and daylight improves human comfort and well-being.

KPFF designed the steel lateral system to an enhanced performance objective, improving the resiliency of the structure. To **reduce embodied carbon impacts**, KPFF worked together with the concrete ready-mix supplier to use extended 56-day strengths and provide 70% cement replacement in the foundation and 50% cement replacement in the floors. These mixes drove significant reductions compared to regional baselines, saving the project approximately 600 metric tons of carbon dioxide equivalent or over 10% of the total structural embodied carbon (based on Tally life-cycle analysis data and 2023 NRMCA regional benchmarks).

Photo credit: City of Sunnyvale

02

Embodied Carbon Leaders at KPFF

KPFF has two designated Embodied Carbon Champions for our firm: Molly Seto of the San Francisco office and Shana Kelley of the Seattle office. However, **our leadership group for embodied carbon within our firm has had enormous growth** over the last few years. As we've expanded our focus on quantifying and making embodied carbon reductions on projects across our practice, several of our office locations have identified one or more leaders responsible for educating and advocating within their office. This distributed approach to leadership is essential in making sure we are constantly **growing our embodied carbon expertise** and that we are accounting for the regional differences of our projects.

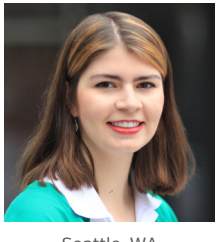
SHANA KELLEY

Seattle, WA

MOLLY SETO

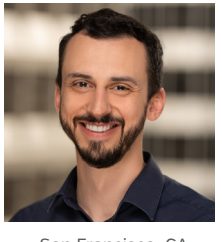
San Francisco, CA

ELLA YAZBECK



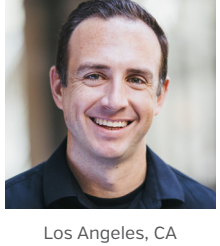
Seattle, WA

NICHOLAS MILEY



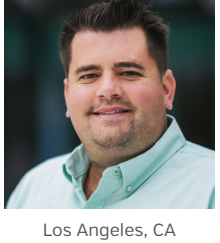
San Francisco, CA

KANE PITHEY



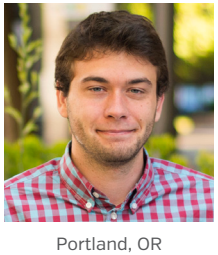
Los Angeles, CA

ALEX MUELLER



Los Angeles, CA

REID ZIMMERMAN



Portland, OR

MATT HOFFMAN

Portland, OR

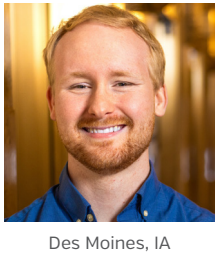
EMMA ELLRICH

Salt Lake City, UT

TAMARA CARDENAS

San Diego, CA

ERIC SCHAFFER



Des Moines, IA

Leadership Highlight >>

KPFF Embodied Carbon Summit

Spring 2023

In spring 2023, the KPFF Structural Sustainability leadership group held the second KPFF Embodied Carbon Summit. It was attended by twelve sustainability champions from eight offices around the nation. This summit built on the focus of the inaugural summit, held in 2021, which introduced sustainable design techniques and formally created the Sustainability Group. Champions returned after two years of practice and implementation, ready to share lessons learned, best practices, and advancements in sustainable materials and design techniques.

The first day of the 2023 EC Summit focused on internal education including sustainable design programs, best practices when conducting

life cycle assessments, and the state of practice in each office. Many of the practices and case studies showcased design techniques that are on the forefront of sustainable design and inspired all involved to push further.

The second day of the 2023 Summit focused on marketing opportunities and a continuing education session focused on Life Cycle Assessment. The marketing opportunity session focused on client needs and opportunities for KPFF to provide effective and meaningful sustainable design services.

03

Reduction Strategy

Much of our effort this year has been tied to our exploration of structural carbon reduction strategies on a variety of projects. A key element has been better understanding both the large and small variables in our designs that impact embodied carbon. Regardless of whether or not a project is pursuing specific environmental goals, we can influence carbon reduction through a number of strategies.

Structural System Selection

Many projects begin with specific environmental goals or considerations, addressing the embodied carbon impacts of different structural systems in requests for proposals and project interviews. These owners and architects expect **embodied carbon discussions** when we are exploring structural systems.

To guide teams in these early stages and have ready, relevant answers, we have focused on developing a comprehensive understanding of the impacts of structural system selection. We have done this by creating our own **in-house database of structural system life cycle assessments.** Even on projects without named sustainability goals, this database can help guide conversations when making structural system choices.

Project Highlight >>

Mass Timber Bunkhouse

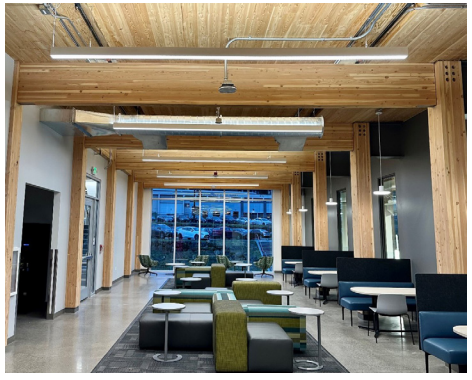
Pine Valley in Eastern San Diego County, CA

Located on a 4,000-acre working ranch, this building incorporates efficient CLT layouts for the bearing walls, second floor, and roof, with precision fabrication used to ensure minimal waste on a site with limited road access for large trucks. The result is a primary structure that was erected in only 5 days, with hidden connections that feel simple yet intentional.

Project Highlight >>

Milgard Hall

Tacoma, WA



One of the best ways to lower the embodied carbon of the built environment is to compare the impacts of different possible structural systems, which typically account for a majority of the embodied carbon of a building. A great example of this is the **whole-building life cycle assessment** that KPFF performed for the new Milgard Hall building on the Tacoma Campus of the University of Washington, a building designed by Architecture Research Office (ARO). This new interdisciplinary building will house elements of the Milgard Business School, new labs for the School of Engineering and Technology, an expanded Global Innovation and Design Lab, a High Impact Practices learning space, and new classrooms.

To compare possible structural systems for this project, whole-building life cycle assessments were performed to examine the differences for timber, steel, and concrete structural systems. KPFF created separate models, including structure and enclosure, for all three scenarios to quantify the environmental impacts of each building with the Tally WBLCA software.

The report on the evaluation included a **transparent description of how biogenic carbon was evaluated** and the end of life assumptions used to determine the amount of carbon sequestered by the mass timber structure. In addition to environmental impacts over the whole life cycle of the building, embodied carbon impacts at the initial construction of the building were also provided.

A mass timber structure was ultimately selected for the building. This resulted in a carbon reduction for the whole building, with respect to an all concrete structure alternative, of 43% over the entire life cycle, with **over 1 million kilograms of carbon emissions avoided**. When looking at initial embodied carbon, the sequestered carbon in the mass timber structure offset nearly all the carbon emissions attributed to the non-wood portions of the structure, including the concrete and reinforcing in the foundations. The choice to use mass timber required coordination across the entire integrated design-build team, which was led by Andersen Construction, proving that **collaboration is key** in prioritizing carbon reductions in building designs.

Material Reuse

Even when reusing an entire structure is not an option, there are still opportunities to **incorporate elements from demolished projects in our new construction.** A great example of this is the Federal Center South project in Seattle, where we used 200,000 board feet of wood framing from an existing structure demolished on-site. This is roughly equivalent to the yield of 4 acres of Washington forest. This work required extensive cataloging of the existing framing, unique and flexible detailing, and structural testing to fully capture the capacity of the existing wood.

This past year we have explored new ways of detailing our current systems to consider end-of-life reuse. In collaboration with ZGF Architects, we are exploring CLT system design, using our experience in lab testing composite CLT systems to help determine how these systems are disassembled.

200,000 BOARD FEET OF WOOD FRAMING USED FROM AN EXISTING STRUCTURE DEMOLISHED ON-SITE

Retrofits / Adaptive Reuse

A key reduction strategy that we are really excited about is adaptive reuse and retrofitting existing structures to create new spaces. **Retrofitting existing structures uses the carbon we have already spent** and can significantly increase the building's useful life. Retrofits have always been a part of our practice, but we are improving our ability to help clients quantify the environmental costs of retrofitting versus building new.

FEDERAL CENTER SOUTH

Material Specification

Once the structural system has been selected, the next opportunity to reduce embodied carbon is material selection. We have made the biggest impacts through **changing how we specify high EC intensity materials** such as concrete and steel. Several of our offices have implemented location-specific language requiring environmental product declarations (EPDs) and/or global warming potential (GWP) reductions on certain projects.

Keeping it Local

Embodied carbon reduction strategies need to vary depending on the location of the project. The knowledge base and information available regarding the embodied carbon of structural materials widely varies across the nation. This variability applies to information about local building materials as well as contractor knowledge. Each project's embodied carbon goals need to recognize this variability and be **customized for the project location**.

For example, many of our offices require reporting and reductions for embodied carbon in concrete submittals. Where EPDs are readily available, the specifications can be written to require a calculation of the reduction from a regional baseline. Where EPDs are not readily available, limitations on high embodied carbon constituents can be specified instead.

Being Flexible

We have learned to **stay flexible** when selecting embodied carbon reduction strategies. On multiple projects, specified materials became unavailable due to supply issues. For example, Type IL cement was unavailable from one of the main concrete suppliers in the Seattle area for a number of months due to shipping issues and a fly ash shortage in the San Francisco Bay Area. In these cases, we have to adjust and evaluate the impacts of the changes. In many cases we have been able to find alternate EC reduction pathways, such as the use of lower-carbon reinforcing steel or the use of alternative supplementary cementitious materials, to still maintain the reduction goals of the project.

04

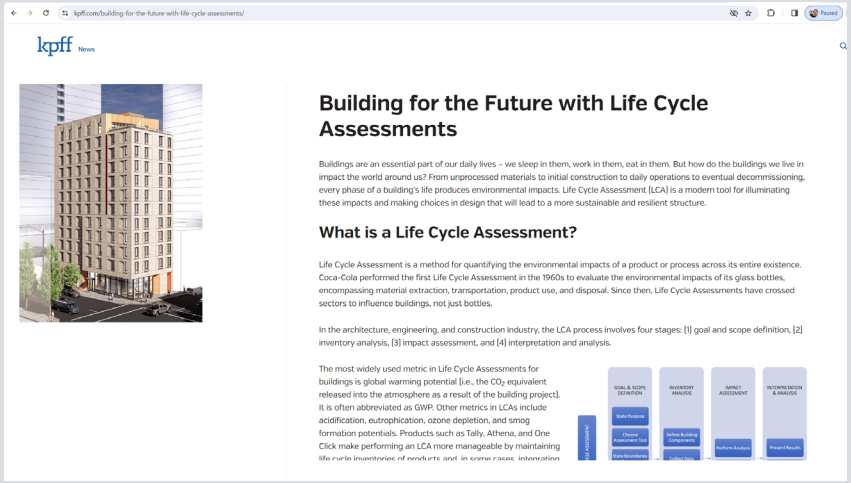
Education Plan

In 2021, during KPFF's first year as a SE 2050 Signatory, we created a Structural Sustainability group made up of **sustainability champions** identified from each office. See the Leadership Highlight earlier in this ECAP for a description of our recent Embodied Carbon Summit.

In addition to the internal Embodied Carbon Summits, KPFF provides avenues to share lessons and expertise within the firm. We have created a firm-wide portal for structural sustainability on our Microsoft Teams hub that is accessible by all KPFF employees as a means to broadcast sustainability messages. We have many employees who actively give and attend presentations by the **Carbon Leadership Forum, ASCE,** local **Structural Engineering Association** chapters and material suppliers. A resources section includes documents from SE 2050, as well as copies of internal presentations and resources. The **Question and Message Board** page allows structural engineers to share resources and get advice from engineers throughout the firm.

Some offices have started their own internal Sustainability Groups. These office Sustainability Groups are a great way to **engage our younger staff** who are passionate about sustainability.

Education Highlight >>



A recent blog post, from EC Champions Emma Ellrich in the KPFF Salt Lake City office and Reid Zimmerman in the KPFF Portland office, discussed the importance of life cycle assessment (LCA) in structural design. The blog post described background on what LCA is and what can be gained from adding such an evaluation to the selection of structural systems. The post finished with a description of a case study of a project in Utah, quantifying the real environmental impacts that structural system selection can have.

Read more here: https://www.kpff.com/building-for-the-future-with-life-cycle-assessments/

05

Knowledge Sharing

Our approach to **advocacy** for embodied carbon reduction over the last year focused on sharing our experiences, advocating on our local projects, and advocating in the wider industry.

As we have been developing our knowledge base for embodied carbon in structures, we have found ways to **share these lessons** in local and national organizations. As noted in the elective section, we participate in and present on embodied carbon topics related to structures in these organizations. We will continue to work on engaging and contributing in the coming year.

For our local projects, we proactively discuss pathways to embodied carbon reduction with architects, owners, jurisdictions, and contractors. One of the biggest roadblocks to embodied carbon reduction is reticence to change construction methods. By sharing evidence of projects **successfully implementing low-carbon strategies** and selectively test-running new materials or systems, we continue to move the needle forward.

As structural engineers, we have many opportunities to engage with contractors and suppliers on a wide range of materials for structural systems. We will continue to develop a better understanding of how the manufacturing processes for these materials contribute to EC while finding opportunities to **advocate for new and effective solutions.**

Presentation Highlight >>

Going Deeper with Structural Sustainability

Over the past year, several KPFF engineers have given presentations to clients, professional organizations, and sustainability groups. As an example, this past year Shana Kelley, of our Seattle office, was a speaker at an NCSEA presentation titled “Going Deeper to Structural Sustainability” with over 300 webinar attendees.

06

Reporting Plan

KPFF's approach to measuring, tracking, and reporting embodied carbon is very much on a project-by-project basis. As the approach and resources highly depend on project goals and location, we utilize a host of different strategies and best match them to each specific project.

When calculating the embodied carbon of structural materials, we try to utilize the most **realistic EC intensities for materials** used on our projects, both for baseline and proposed models. For example, many of the markets that we work in do have extensive EPDs available for local concrete; however, some do not. We have found that the availability of EPDs for many structural materials is increasing for both local and regional materials. As EPDs continue to be uploaded to the Building Transparency tool, we will be able to filter industry and product EPDs there as well.

The software we use for **life cycle assessments** and for evaluating EC impacts on projects depends on the project's specific sustainability goals and certifications. Embodied carbon tracking software programs that have been commonly used on our projects include Tally, Athena, and EC3. Use of the TallyCAT tool is also being explored to better integrate Autodesk applications and EC3 on our projects.

The life stages included in the life cycle assessments we have done in the past depend on the purpose for performing the LCA. Where a choice between products for specific materials is being considered, we will sometimes look only at the cradle to gate embodied carbon using EPDs. However, when looking at overall structural systems, we include more stages. Both LEED and ILFI certifications have different requirements for the life stages to include, so those requirements often control what is included. When producing reports outlining our findings, we always include a summary of what life stages are included.

University of Utah Mental Health
Salt Lake City, Utah

When embodied carbon is being studied early on in a project, the material quantities may only be estimated from previous similar projects. For projects that are further along in design, many of our current structural projects are modeled in Revit, and we have found that this is one of the most accurate ways to extract material quantities. Timing of extraction of material quantities will vary depending on project goals.

Project Highlight >>

PAE Living Building

Portland, OR

Situated among century-old buildings in a historic downtown Portland district, the PAE Living Building is the first developer-driven and largest commercial urban living building in the world. It is a demonstration of the feasibility of developing competitive office space in city centers while achieving **net zero carbon emissions**. Winner of the ENR Regional Best Project, it was designed and engineered to meet the most rigorous sustainability standards.

A combination of on-site and off-site solar power, along with on-site energy storage, provides 105% of the building's energy demands. Freshwater is collected on-site, stored in an underground cistern, and treated to provide 100% of the building's freshwater demand, and 30 gallons of wastewater per day is collected, treated, and re-purposed into fertilizer. The building can operate independent of city utilities.

The building's primary structure uses **mass timber** for its floors and columns, instead of steel or concrete, resulting in a reduced embodied carbon footprint. Exposed timber on the interior provides a 1-hour fire resistance rating for the Type III-A construction.
To allow the building to quickly return to operation after a seismic event, it was designed to a Risk Category IV performance level, providing **seismic resiliency** similar to hospitals and emergency services structures.

All project sustainability goals were delivered on budget and the office space is leased at competitive market rates. The PAE Living Building proves that it is possible to achieve net negative carbon sustainability in an urban office space environment.

07

Electives

We have reviewed the electives we included in our 2023 ECAP and we were able to achieve all those listed. See below for the electives we have selected to focus on this year.

Reduction (1 required, 4 recommended)

✓ Update your specifications to incorporate embodied carbon performance. Include embodied carbon in your submittal review requirements.

We continue to expand the use of requirements for EPD submittals and GWP reduction calculation in specifications on multiple projects.

✓ Communicate the embodied carbon impacts of different design options to clients with creative and effective data visualization.

✓ Compare different design options with embodied carbon as a performance metric during the project concept phase. Explain what you did and how the results changed (if anything).

See project highlight in this ECAP on our Milgard Hall project. We have done similar material comparisons on many projects during early design.

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

✓ Collaborate with your concrete supplier to reduce embodied carbon in a mix design below an acceptable baseline (e.g. NRMCA regional baseline values).

✓ Incorporate sustainably harvested biogenic materials in at least one project.

Many of our projects incorporate timber structural members that are certified to be sustainably harvested by FSC, SFI, or through project-specific material tracking.

Education (2 required, 4 recommended)

✓ Provide a narrative of how the Embodied Carbon Reduction Champion will engage embodied carbon reduction at each office.

See the education section in this ECAP for more information about how our embodied carbon leads across our offices collaborate and educate our engineers.

✓ Present at least (1) webinar focused on embodied carbon and make a recording available to employees.

This past year, we've been focusing on sharing expertise from across our offices and we plan to continue sharing knowledge across offices this year. We're also coordinating having outside experts present to several of our offices at once.

✓ 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.

See our Education Plan section for a description of internal KPFF Sustainability Groups.

✓ 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.
Our firm-wide MS Teams page has a Structural Sustainability page that is accessible by all KPFF employees. Engineers post resources to this page and give advice on the Q&A board.

✓ Engage with a CLF Regional Hub.

Several of our employees regularly attend CLF regional hub meetings and events. Shana Kelley in our Seattle office co-leads the CLF Seattle Hub.

Advocacy (2 required, 4 recommended)

✓ Describe the value of SE 2050 to clients.

KPFF regularly features our commitment to SE 2050 in our marketing materials, proposals, and our communications with clients.

✓ Publicly declare your firm as a member of the SE 2050 Commitment however you see fit.

When we first joined the SE 2050 commitment, a blog post describing the program and our work in adopting the commitment was posted on our website here: https://www.kpff.com/blog/news/post/kpff-is-a-signatory-of-se-2050. As we further develop and grow with the commitment, we will continue to post progress updates on our website at https://www.kpff.com/news/

✓ Give an external presentation on embodied carbon that demonstrates a project success or lessons learned.

✓ Engage with structural material suppliers in your region to communicate the importance of Environmental Product Declarations (EPDs) and low-carbon material options.

✓ Engage with local, state, and federal governments to communicate the importance of low-embodied carbon procurement and construction policies, and provide expert testimony to this effect.

One example of advocacy efforts we have made in the last year is that the Seattle KPFF office signed on to a February 2023 support letter for embodied carbon limits in the Seattle Building Code. This letter, which was signed by many local designers and builders, encouraged the code advisory board to implement a proposal for embodied carbon limits for steel and concrete in larger projects in the City of Seattle.

Reporting (1 required, 2 recommended)

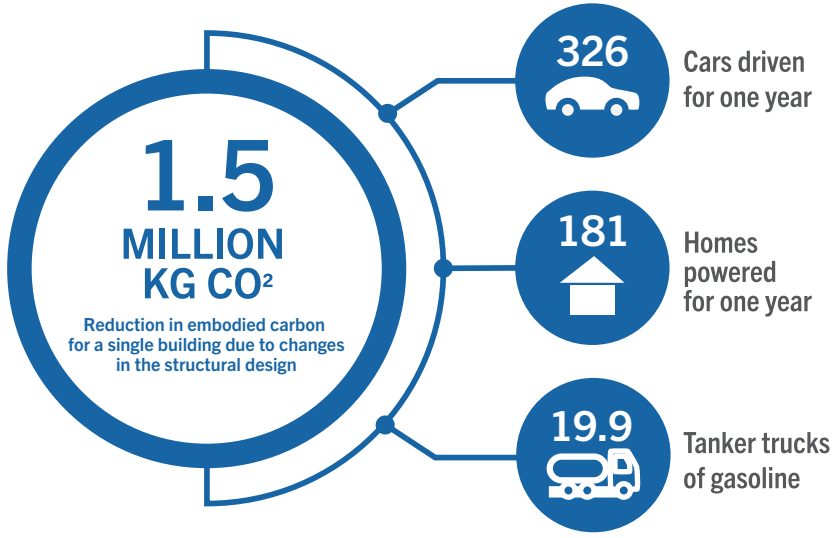
✓ Submit a minimum of (2) projects per U.S. office with structural engineering services to the SE 2050 Database. You are not required to submit more than (5) total projects across your firm.

✓ For multi-office firms, describe how each office is measuring and reporting embodied carbon.

Each office individually decides how they are measuring and reporting embodied carbon. This year, we had a KPFF Embodied Carbon Summit to discuss shared resources and approaches for reporting and measuring embodied carbon. See our Education Plan section for more information.

✓ Propose other actions that promote the reporting of embodied carbon data and describe their value

Internal training for embodied carbon measurement: We have given presentations to several KPFF offices regarding the measurement of embodied carbon of both specific materials and of a whole building. We will continue to provide resources and presentations for the measurement of embodied carbon, to ensure that more reporting takes place.



Example of Embodied Carbon Reductions Achieved on a KPFF Project

08

Lessons Learned

With the rapid expansion of embodied carbon knowledge and practice across our offices, we learned plenty of lessons during 2023. Below is an example of what we have learned as we have expanded expertise across our offices.

One of our biggest goals this past year has been to expand the structural sustainability expertise in our offices beyond our bigger hubs. Two great examples of this are our Des Moines, Iowa office and our Mountain West group located in Boise and Salt Lake City.

From our Des Moines office:

In the past year, our KPFF Des Moines office has actively fostered local discussions on embodied carbon. Drawing on insights from our west coast offices, we've recognized the significance of conveying to clients how structural system choices impact overall embodied carbon emissions. We have learned that we can work to advance conversations on sustainability in our local market by presenting clients with estimates of embodied carbon emissions linked to different structural system layouts and material types and by providing them with potential reduction strategies. While not every project may prioritize embodied carbon reduction, we have found that educating clients on the role of the structural engineer in building sustainable structures allows us to have meaningful conversations about sustainability.

From our Mountain West office:

In the Mountain West region, we have found supportive clients and partners in implementing sustainability-focused solutions. However, the most common roadblock we've faced when suggesting sustainable innovations has been fear of the unknown or reluctance to invest in learning how to implement new practices. To address this, we have taken an active approach in architect and contractor education. We provide AIA-accredited informational sessions for architectural firms, detailing sustainable strategies. On the contracting side, we have met with local concrete suppliers to understand their challenges in implementing more sustainable concrete mixes and have gone beyond our normal level of support to help them in construction.

In the next year, we are hoping to further expand our focus on embodied carbon in all our offices.

Seattle
Tacoma
Lacey
Spokane
Portland
Eugene
Sacramento
San Francisco
Los Angeles
Long Beach
Orange County
San Diego
Boise
Salt Lake City
Austin
Des Moines
St. Louis
Chicago
Indianapolis
Nashville
Birmingham
Louisville
Cincinnati
Washington, DC
New York

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Children's Museum of Eau Claire