ARUP

Our transition to a zero carbon future

SE 2050 Embodied Carbon Action Plan

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Embodied Carbon Action Plan

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A climate emergency is upon us. As structural materials represent about 12% of global greenhouse gas emissions, our structural engineers recognize their role in achieving net zero embodied carbon structures by 2050.

Arup is committed to shaping a better world, creating shared value for our clients and communities, and safeguarding our planet. Every part of our firm has a role to play in making sustainable development central to our business. Sustainable development is fundamentally about creating a balance between the needs of a growing world population and the finite resources and health of our planet—our life support system.

Arup embodies 'total value' with a holistic design approach, integrating a wide breadth of advisory services and skills in sustainability and resilience, digital, buildings and building envelope design, infrastructure, and masterplanning. We have the opportunity to use our design and advisory services to produce safer, more inclusive, resilient and sustainable cities and infrastructure.

In October 2017, Arup made a commitment to contribute meaningfully to the UN Sustainable Development Goals. As designers, engineers and advisors, our skills and vision are increasingly in demand from clients and partners wanting to transition to a more sustainable future.

It is up to each of us individually to drive change forwards in the areas where we have responsibility. Everyone has a role to play inspiring and supporting our clients and colleagues alike by offering innovative ideas, and challenging the status quo. We are proud to have been part of the development of the SE 2050 Initiative since 2014 and to now be among the inaugural signatories to the Structural Engineering Institute's SE 2050 Commitment.

The mission of the SE 2050 Commitment is to support the SE 2050 Challenge and transform the practice of structural engineering in a way that is holistic, firm-wide, project based, and data-driven. By prioritizing reduction of embodied carbon, through the use of less and/or less impactful structural materials, Arup is working to achieve net zero embodied carbon structural systems by 2050.

Our commitment requires the publication of our strategy in the areas of education, reporting, reduction, and advocacy. Our Embodied Carbon Action Plan for North America leverages our strong internal skills networks and aligns with our global commitment to contribute meaningfully to the UN Sustainable Development Goals.

Strategic focus areas
Arup is working to achieve net zero embodied carbon structures by 2050.

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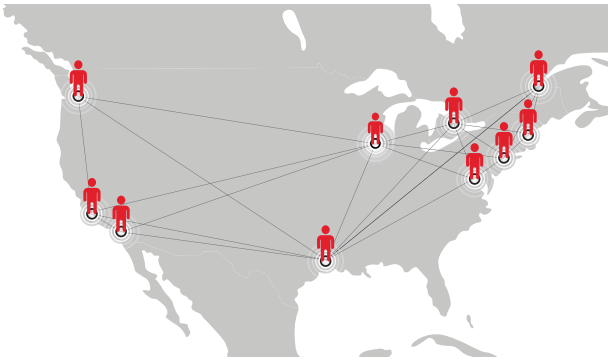
Arup's vision is to equip our structural engineers with the skills and insights necessary to implement the Embodied Carbon Action Plan in all offices and on all future projects.

Education

As a global firm, Arup's unique culture embraces knowledge sharing and collaboration in a way that enables us to easily tap into our collective capabilities across great distances. This is done primarily through our skills networks, of which the structural skills network (SSN) is one of the oldest and strongest. Within the SSN, there are regional sustainability hubs that keep the teams connected within and across regions.

The North America hub is comprised of structural sustainability champions from ten of our offices who act as internal and external representatives for embodied carbon resources and educational programs.

This group is currently led by the regional champion, Frances Yang, who is the point of contact for SE 2050 and is responsible for coordinating embodied carbon efforts at a global level.



Arup sustainability champions

Ten of our offices in North America are well connected through our structural skills network and local sustainability champions.

- Boston
- Chicago
- Houston
- New York
- Montreal
- Los Angeles
- San Francisco
- Seattle
- Toronto
- Washington D.C

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Our aim is to make embodied carbon reporting a normal part of the design and delivery of every project.

Reporting

Regionally appropriate tools will be used by project teams to complete life–cycle assessment (LCA) studies. A project information database, the Arup Carbon Insights Platform, is in development to compile results from the life–cycle assessment models in a format that is compatible with the SE 2050 database.

We commit to calculating embodied carbon for a minimum of five projects for Arup North America—aiming for two projects per office this year, and with the ultimate goal of all future projects.

Project delivery

Arup's high-level process for integrating embodied carbon reduction and reporting into projects.

- Clarify intent
- Define scope

- Hotspots
- Benchmark
- Supply-chain research

- Narrow options
- Test strategies
- Draw up pros & cons

- Design and coordinate
- Incorporate in drawings and specs
- Review submittals

- Capture internally
- Share externally

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Only by working together and ever widening our circle of partners can we achieve a healthy, carbon- neutral built environment.

Reduction strategy

As Arup's global strategy calls on us to transition to a zero–carbon economy and respect our planetary boundaries, we have developed resources to support structural engineers in reducing embodied carbon in their designs.

We seek to make reduction in embodied carbon a key design criteria alongside cost, future flexibility, speed of construction, and best practice. Our regional structural skills network (SSN) provides guidance on several strategies, which include:

- specifying low–carbon concrete
- sourcing sustainable mass timber
- incorporating salvaged steel
- designing for deconstruction
- pushing material efficiency beyond standard practice

Many of these are aligned with the SE 2050 electives. Each office will choose from these strategies and other SE 2050 electives to employ at least one elective on chosen projects. Embodied carbon savings will be calculated to show the effects of improved design and specifications and used to spread awareness both internally and externally.

Advocacy

Arup has been sharing knowledge and data on embodied carbon with the buildings industry for over a decade. Our SSN sustainability representatives are active participants in external organizations such as the SEI Sustainability Committee, Carbon Leadership Forum, SEAONC Sustainable Design Committee, and the SE 2050 leadership group.

By acknowledging the greater role and responsibility of structural engineers in reducing carbon emissions, we have expanded our technical services to offer:

- whole–building life–cycle assessments
- embodied carbon policy assistance
- third–party expert support on low–carbon concrete
- design for circularity
- other non-traditional design strategies

We realize that reaching net zero embodied carbon is an ambitious goal that will take significant collaborative effort. Arup will continue to seek out ways to engage with others in the buildings industry, inclusive of clients, policymakers, manufacturers, builders, academia, and our peers.

Our partners

SEI Structural Engineering Institute ASCE | SE2050 Committing to Net Zero

IStructE | CLF Carbon Leadership Forum

architecture 2030 | EBNet Ecological Building Network the art and science of building well

Ellen MacArthur Foundation Rethink the future | U.S. Green Building Council USGBC

Case studies

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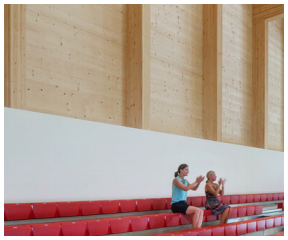
SE 2050 requires us to Plan, Implement, and Share. These past Arup projects illustrate what "implementation" looks like and show us the critical role structural design can have in achieving net zero carbon projects.



Client
KLH US Ltd.

Project owner
Washington Latin Public Charter School

Key collaborators
MCN Build
Perkins Eastman
demian\wilbur\architects
SK&A

Key facts
11,000ft² gymnasium
Cross laminated timber and glulam structure
Completed June 2016

Key services provided
Structural engineering
Fire/life safety consulting

Washington Latin Public Charter School

Washington, DC

The new basketball court uses a full timber solution with glulam beams and columns and cross laminated timber (CLT) panels. CLT is a flexible building system made from industrial dried lumber stacked together at right angles and glued over their entire surface. The product is exceptionally strong, retains its static strength and shape, and has a low carbon footprint.

Washington Latin is the first building to use this material in Washington, DC. CLT is currently not included as an accepted material in the building code. Arup worked directly for the supplier, KLH, to translate their product and preferred details to an approved solution. As the structural engineer and fire/life safety consultant, we developed a code modification to allow the use of CLT as a fire safe material, gaining approval by local authorities.

Arup's wood carbon analysis further enhanced the project's sustainability story, illustrating and quantifying the lower embodied carbon of wood in comparison to steel or concrete structures, on top of the unique attribute of structural wood products to sequester and lock up carbon for decades.

Project owner
U.S. General Services Administration

Key collaborators
Morphosis
SmithGroupJJR

Key facts
18-story office tower
605,000ft²
LEED Silver certified

Key services provided
Structural engineering
Fire/life safety consulting
MEP Engineering

San Francisco Federal Building

San Francisco, CA

The structural design team worked very closely with Arup MEP to design a wave-formed structural concrete slab that eliminated the need for HVAC systems and reduced lighting on the top 13 floors. This analysis allowed the owner to achieve over 120,000ft² of naturally ventilated office spaces.

The structural system for the tower is an all-concrete sheer wall construction, using up to 70% slag in substition of carbon-intensive Portland cement. Arup's approach eliminated the need for a secondary lateral system, resulting in a savings of $5m, as compared to the prescriptive requirements imposed by the building code.

The services for the upper 13 naturally ventilated levels uses 50% of the energy used by equivalent sized, typical California office building.
San Francisco's temperate climate and the building's height led Arup to incorporate wind driven cross ventilation for cooling. The building management system monitors indoor temperature and outdoor conditions to automatically adjust operable windows.

Table of requirements: Education

Arup satisfaction of requirements	Requirements/Electives	Implementation
✓	Distribute firm-wide announcement of your firm's pledge to joint the SE 2050 commitment.	In addition to an announcement in Americas Regional News (ARN) on Structural Skills Network (SSN) Forum post, we will announce our commitment through our SSN monthly call in February and review the ECAP.
✓	Provide a brief narrative describing how your firm is promoting a firm-wide education program for embodied carbon reduction and the firm's commitment to SE 2050	Through our SSN, we regularly share tools and procedures to educate all structural engineers in the region. Our implementation plan for the Emboded Carbon Reduction Plan will be shared through our monthly calls and the structural sustainability champion in each office.
✓	Nominate an Embodied Carbon Reduction Champion for your firm. Include a brief profile in your ECAP.	Arup has a network of structural sustainability champions for each office who will promote our ECAP. A profile for Frances Yang who leads this group is provided.
✓	Set a date within the first year to present the "Embodied Carbon 101" Webinar to your firm. Incorporate this information into your orientation/on-boarding programs.	Individual offices will broadcast the "Embodied Carbon 101" Webinar the months of February/March 2021, as well as introduce their structural teams to the ECAP.
✓	Minimum (1) additional elective to educate your firm about embodied carbon and a narrative of its significance.	See electives below.
✓	Have one representative of your firm (any employee) attend quatterly external education programs (e.g. webinar, workshop) provided by SE 2050, Carbon Leadership Forum (CLF), or other embodied carbon resources.	External education opportunities are posted on our Teams site and are shared during our bi-monthly calls. We will ensure at least one of the office sustainability champions attends an external education event between calls.
✓	Share the SE 2050 library of resources with technical staff.	The SE 2050 library of resources will be shared with the firm-wide presentation. The link to the SE 2050 library of resources will be embedded into the structural skills website of technical content that is accessible to all of our engineers.
✓	Share the embodied carbon reduction strategies with your firm as outline in Top 10 Carbon Reducting Actions for Structural Engineers document produced by SE 2050.	The embodied carbon reduction strategies will be shared and discussed alongside the Embodied Carbon 101 webinar.

Table of requirements: Education

Arup satisfaction of requirements	Requirements/Electives	Implementation
✓	Nominate a minimum of (1) employee per office to participate in a CLF Community Hub.	Arup will encourage the SSN Sustainability group representatives to participate in their local CLF Community Hub, if one exists.
✓	Provide narrative outlining plans for minimum (2) firm-wide presentations per year on the topic of embodied carbon.	Within our monthly SSN meeting, we will incorporate at least 2 presentations on the topic of embodied carbon, within the year, either through project work or resources.
✓	Present the document "How to measure and report embodied carbon" to all technical staff.	This document co-authored by our colleague in Arup UK has been shared with our global Structural Engineers Sustainability Hub.
✓	Attend a presentation or demo of an LCA-based tool used to calculate embodied carbon.	Opportunities to attend presentations and demos of LCA-based tools will be shared with the SSN Sustainability representatives.
✓	Initiate an embodied carbon interest group within your firm and provide a narrative of their goals.	Arup currently has multiple groups: SESH (Global, Americas, UK), Arup Carbon Tool, Americas Region Decarbonization Group. These groups are available on the Teams platform and continually keep members apprised of news and resources related to embodied carbon.
✓	Provide a narrative of how the Embodied Carbon Reduction Champion will engage embodied carbon reduction at each office (intended for multi-office firms).	Our structural Skills Network has a sustainability group with representatives from each office. We meet monthly and have a Team site SESH AMR. Each is an Embodied Carbon Reduction Champion (Champion) for their office and the group is lead by regional Champion who is the point of contact for SE 2050 and also ensures coordination with our global embodied carbon efforts. The office champions are responsible for implementing the ECAP.
	Other actions you feel appropriate and a narrative for why.	

Table of requirements: Reporting

Arup satisfaction of requirements	Requirements/Electives	Implementation
✓	Provide a narrative on how your firm plans to measure, track and report embodied carbon data. Here are some considerations you may want to include: • How will you calculate embodied carbon for structural materials? Do you have access to product—or region—specific EPDs? • What commercially available LCA software will you be using to quantify embodied carbon? • What life cycle analysis (LCA) methodology will you use? Define where you plan to delineate scope (e.g. A1–A5 or whole life cycle), communicate inherent assumptions, etc. • How will you extract material quantities and how often? (currently for internal use and not required in SE 2050 Database)	For each project that we decided to report embodied carbon for, it will be up to the project team which tool they wish to use. Within Arup we have access to Athena Impact Estimator, Tally and EC3, and internal Arup Carbon tool. We plan to only use tools that are regionally appropriate for the project calculation and aim to complete full LCA studies spanning modules A to C. We are beginning to develop tools to better utilize our Revit models to extract material quantities and link quantities and LCA results to the Carbon Insights Platform, a project information database. Our plan is for this to fully compatible with the SE 2050 database.
✓	Describe the internal training for embodied carbon measurement you provided or will provide.	All structural engineers nominated to conduct the embodied carbon calculations will be pointed to the training resources and have a list to experts to turn to if they have further questions.
✓	Submit an annual minimum of (2) projects per U.S structural office or (5) projects for the firm to the SE 2050 Database.	We can commit to 5 projects for Arup North America and will aim for a minimum of two projects per office.
	Submit all projects to the SE 2050 Database.	Our aim is to make the process as efficient as possible and give engineers the insights that will motivate them to perform embodied carbon calculations for all future projects.
	For a project submitted to the database, ask the Architect or Owner if the project has a carbon budget or if there established project sustainability goals at the project kick-off meeting.	Using the collection of precedents we can improve our position to establish carbon budgets collaboratively with the architect and owner at the start of projects.
	Meet your target average embodied carbon reduction from the previous year.	The objective is to use the data collected in the first year to esablish a target to meet for the next year.

Table of requirements: Strategies

Arup satisfaction of requirements	Requirements/Electives	Implementation
✓	Set a goal for the coming year and an implementation narrative. For second year's ECAP and beyond, describe successes and misses to help the program improve. Qualitative goals are encouraged for the first year.	Implementation of the "Top 5" list presented in SSN global forum, demonstrated on at least one project per office: use of our concrete specification guidance, consideration of sustainably sourced mass timber instead of concrete/steel, attempt to source salvaged steel, designed for deconstruction, or pushing material efficiency beyond standard practice. Conduct EC calculation of the improved design and specs to estimate the percent savings.
✓	For second year's ECAP and beyond, provide a narrative about what you have learned about embodied carbon reduction in the past year.	We will provide in 2nd year.
✓	Minimum (1) additional elective you undertook to reduce embodied carbon in your designs, why you chose the elective and its significance.	Each office can choose from the electives list, must employ at least one elective on the chosen project.
	Incorporate data visualization into your ECAP. How are you looking at data to make informed design decisions and communicate design options to your clients?	
✓	Provide a project case study in your ECAP that captures a reduction of embodied carbon or some lessons learned.	
	Create a project-specific embodied carbon reduction plan.	
	Complete a system embodied carbon design comparison study during the project concept phase.	
	Participate in a LEED design charrette and speak to potential design considerations impacting embodied carbon.	
	Calculate your firm average benchmark for embodied carbon.	

Table of requirements: Strategies

Arup satisfaction of requirements	Requirements/Electives	Implementation
	Update your specifications and incorporate embodied carbon performance. Include embodied carbon in your submittal review requirements.	
	Get a new Environmental Product Declaration (EPD) created on a project.	
	Incorporate biogenic materials on at least one project annually.	
	Collaborate with your concrete supplier to reduce embodied carbon in a mix design.	
	Work with a contractor during material procurement to meet an embodied carbon performance criteria on at least (1) project.	Each office can choose from the electives list, must employ at least one elective on the chosen project.
	Provide a narrative of how circular economy has been used on your projects. Incorporate re-use or design for deconstruction into at least one project.	
	Quantify construction waste reduction on a project.	
	Integrate embodied carbon mitigation strategies in your General Notes.	
	Other actions you feel appropriate and a narrative for why.	

Table of requirements: Advocacy

Arup satisfaction of requirements	Requirements/Electives	Implementation
✓	Provide a narrative about how you plan to share knowledge and data to accelerate adoption of embodied carbon reduction.	Several of the sustainability reps participate in external groups such as the SEI Sustainability Committee, the Carbon Leadership Forum's regional hubs, including LA, Boston, and Bay Area, and SEAONC Sustainable Design Committee. Two of our staff are on the leadership group of SE 2050. Our SE 2050 champion presents regularly at external events targeted towards architects, contractors, academics, manufacturers, and other structural engineers outside of Arup.
✓	Describe the value of SE 2050 to clients. At your option, attach any associated marketing materials.	Our marketing team curated this article for arup.com: https://www.arup.com/perspectives/structural-engineers-hold-the-keys-to-carbon-neutrality
✓	Declare your firm as a member of the SE 2050 commitment on boilerplate proposal language.	Each office has been provided recommended language to add to their proposal templates.
✓	Provide a narrative about how you plan to share knowledge and data to accelerate adoption of embodied carbon reduction.	We have been sharing knowledge and data on embodied carbon with the buildings industry for over decade. A few notable contributions: • Approx 600 data points for the CLF EC Benchmarking Study • Two authors of the ASCE publication Whole Building Life Cycle Assessment: Reference Building Structure and Strategies. https://ascelibrary.org/doi/book/10.1061/9780784415054 • "Top 5 strategies for reducing embodied carbon in structures" presentation within BSA/CLF Boston's Embodied Carbon 101: Basic Literacy webinar which is freely accessible: https://www.architects.org/embodied-carbon-101-video-archive • Climate health actions for the AIA 2050 Materials Pledge
✓	Give a quarterly external presentation on embodied carbon (Tip: Get connected at a CLF local hub near you!)	We easily give more than 4 presentations on embodied carbon a year collectively and will aim to get a larger diversity and spread of speakers during our SE 2050 commitment.
✓	Discuss with the owner/client the option of requiring that some of the structural materials come with facility-specific or product specific EPDs.	Our boiler-plate structural specs have EPD clauses and commentary to guide conversation with the client.

Table of requirements: Advocacy

Arup satisfaction of requirements	Requirements/Electives	Implementation
✓	Share education opportunities with clients.	We will share education opportunities with clients, particularly ones we're speaking at!
✓	Provide a narrative of how you have encouraged industry and policy change incentivizing availability of low-carbon and carbon sequestration materials.	Industry and policy influence to encourage low-carbon and carbon-sequestering materials within last 2 years include: • Country's first Low Carbon Concrete code • Appeal to CBSC to include EC in CalGreen • Participation on North American Wood PCR committee • Partnership with EMF in accelerating circular economy in the built environment
✓	Start an embodied carbon community of practice or mentorship program in your office.	Mentoring is part of the SESH group.
	Mentor a firm new to the embodied carbon space.	
✓	Share your best case studies in your ECAP.	See case studies section above.
✓	Publish a case study or article on embodied carbon.	Arup case studies are in the SEI book Sustainability Guidelines for the Structural Engineer: https://sites.google.com/site/seisustainabilitycommittee/resources/publications/guideline-toc
✓	Give an external presentation about embodied carbon that demonstrates a project success or lessons learned.	We have shared project successes and lessons learned in the BSA "Embodied Carbon 101" webinar, several CLF webinars, and past Structures Congress presentations.
✓	Share your commitment to SE 2050 on your company website.	Our commitment to SE 2050 has been posted here: https://www.arup.com/news-and-events/arup-structural-engineers-commit-to-eliminate-embodied-carbon
	Other action you feel appropriate and a narrative for why.	