

# Embodied Carbon Action Plan



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## EMBODIED CARBON ACTION PLAN



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*Left: Repurposing and vertically expanding the structure at 633 Folsom significantly reduced the embodied carbon that would be required with a new building.*



# Commitment

EMBODIED CARBON ACTION PLAN

## Tipping Structural Engineers has joined the SE 2050 movement with our formal commitment to a path of substantive reductions of embodied carbon in structural systems.

The SE 2050 Program aligns with TSE's culture that exemplifies sustainable design with our ongoing efforts to reduce the short- and long-term impact of building construction on the environment. TSE is part of the growing cadre of firms who are working to combat climate change through education, embodied carbon modeling using LCA methods, and advocacy.

A view toward sustainability guides our analysis of every design problem and is an essential part of every solution. TSE takes an expansive view at the early stages of structural design exploring collaboration and innovation with other disciplines and experts for efficiency, low cost and minimal environmental impact. TSE's designs help reduce the carbon footprint of every structure by:

- ✓ designing efficient structural systems with minimal structural material quantities;
- ✓ designing cost-effective structural systems appropriate for minimizing life-cycle costs;
- ✓ detailing for longevity and adaptability;
- ✓ utilizing locally sourced materials whenever possible;
- ✓ proactively coordinating with the architect and mechanical engineer on key sustainability considerations such as high-efficiency HVAC systems, insulating and glazing assemblies, skylights, and day lighting;
- ✓ protecting the building by designing for enhanced seismic performance;
- ✓ specifying low-cement concrete and high-recycled-content steel that can meaningfully reduce the greenhouse gas impacts of construction;
- ✓ avoiding construction waste and reducing costs; and
- ✓ providing expertise in the design of lightweight and longspan structures.



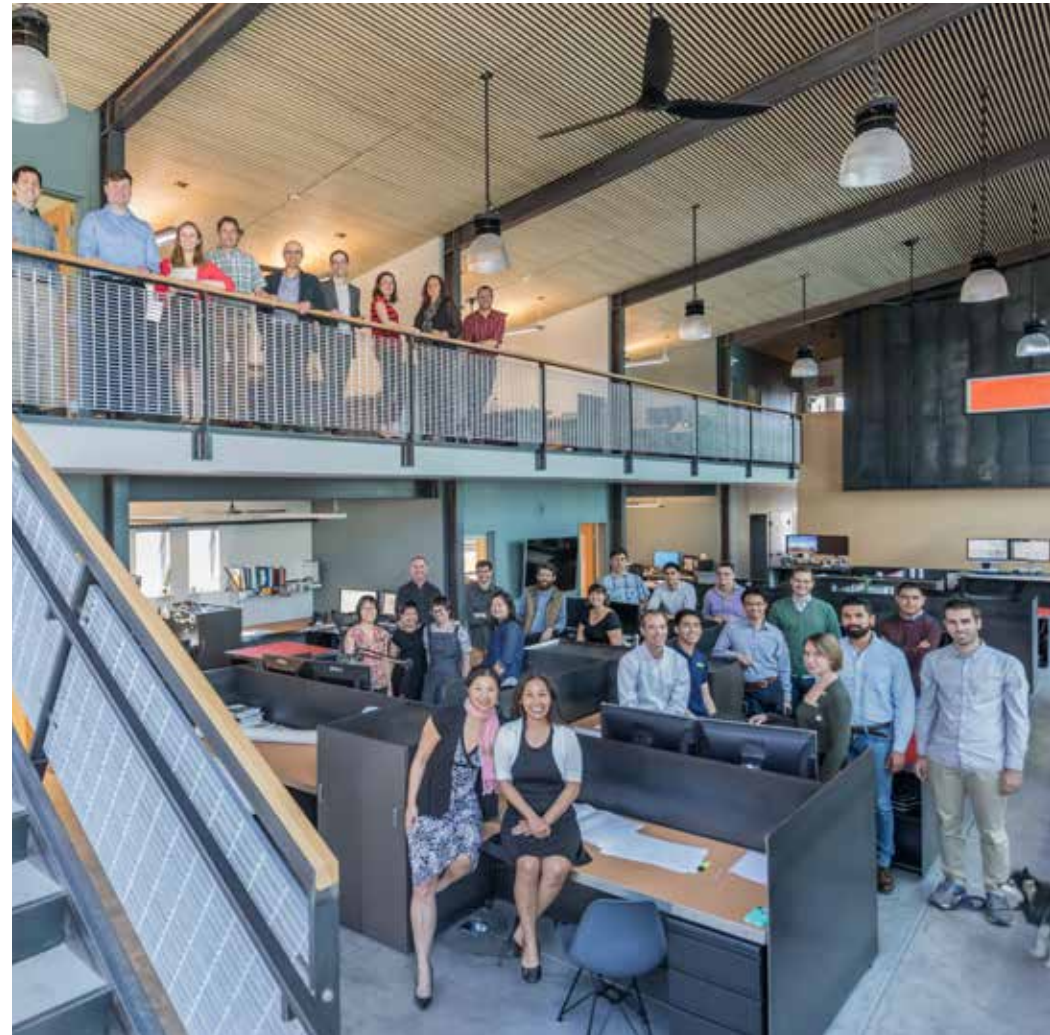
# Commitment

## EMBODIED CARBON ACTION PLAN

TSE has made concerted efforts to research and analyze alternative, resource-efficient materials. These have included:

- ✓ low-cement concrete;
- ✓ mass timber;
- ✓ resource-efficient wood framing;
- ✓ optimized reinforcement grades whenever possible (using higher strength reinforcement); and
- ✓ unconventional and naturally sourced materials:
  - ✓ straw bale
  - ✓ rammed earth
  - ✓ bamboo
  - ✓ tensile membranes

TSE will continue making progress on projects with measured reductions, advocacy, and sharing of our knowledge and data to accelerate widespread adoption of reduced embodied carbon design strategies for the broader industry. TSE is delighted to join the SE 2050 movement to grow and share our commitment to net zero.



# Education

## EMBODIED CARBON ACTION PLAN

TSE has a long standing tradition as an organization that is committed to continual learning and nurturing the educational development and advancement of our staff. We view our commitment to the SE 2050 movement as an inspiring opportunity to expand the knowledge base of our employees into an area of our practice that is relatively new to many, especially our younger engineers. We believe that a robust understanding of how our practice can contribute to a more sustainable future, by lowering the embodied carbon within our building structures, will help our employees become both better structural engineering practitioners and also better stewards of our planet. We view the educational component of SE 2050 as the first essential building block toward creating a new design culture that embodies the sustainability goals necessary to combat climate change and forever reshape the way we as structural engineers practice into the future.

### SE 2050 TIPPING TEAM CARBON

TSE is committed to SE 2050 and we are determined to educate our employees through several different programs focused around sustainability and embodied carbon reduction. TSE has created an internal task group that is centered around the topic of sustainability and understanding of SE 2050 initiatives. This task group is responsible for educating our staff on topics related to embodied carbon and our firm's embodied carbon reduction goals and strategies; it intends to accomplish this by providing a two-way line of communication between the SE 2050 task group and staff members.

The primary line of communication is through the use of a dedicated SE 2050 Slack channel, TSE's main application used for internal communication. The Slack channel will host links to the various industry resources such as:

- ✓ The SE 2050 website;
- ✓ Published papers and articles regarding embodied carbon monitoring and methods for reducing embodied carbon emissions;

### TIPPING TEAM CARBON

#### SE 2050 LEADERSHIP



#### CARBON TRACKING & REPORTING



#### EDUCATION INITIATIVES



*SE2050 Leadership:*  
Bruce Danziger, SE;  
Ian Kelso, SE; Gina Carlson, SE

*Carbon Tracking and Reporting:*  
Nick Strella; Jenna Williams;  
Isaac Williams, CE

*Education Initiatives:*  
Ashley Waite, CE; Joy Wei, SE



# Education

## EMBODIED CARBON ACTION PLAN

- ✓ Tips for adopting sustainability language into conversations with clients; and
- ✓ The Channel will also provide transparency about projects for which we are reporting and tracking embodied carbon.

Not only will the task group provide valuable resources to the firm, but they will provide feedback to questions employees may have to encourage widespread education about the subject.

### RESEARCH INTO MATERIAL AND TECHNOLOGY ADVANCEMENTS

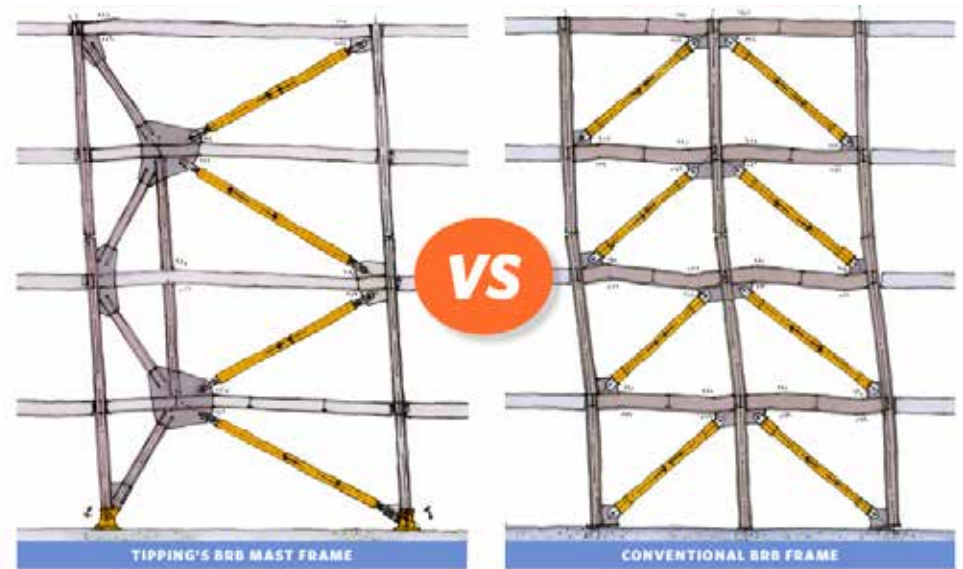
In order to address applicable questions and to encourage embodied carbon reduction practices, a portion of the internal task group's effort is to research and educate the firm on material and technology advancements in the industry. This research includes, but is not limited to, topics such as:

- ✓ discovering alternatives to current SCM replacement materials given fly ash and slag shortages;
- ✓ advancements in steel production technologies utilizing recycled scrap metals; and
- ✓ understanding mass timber's expanding role in the industry and integration into current and future code cycles.

Through the research efforts of the task group, TSE aims to stay at the forefront of advancements in building materials and technologies, remain poised to innovate further embodied carbon reduction strategies, and to find creative new ways to design with those materials.

### INTERNAL EDUCATION INITIATIVES

Beyond the internal task group, TSE is actively encouraging employees to seek further education about embodied carbon reduction practices. We provide opportunities for staff to attend external webinars and conferences that focus on sustainability and embodied carbon reduction through the use of TSE's yearly employee professional development allowance. This allows



*With two recent projects, we found that the BRBM frame was able to cut the number of required frames almost in half and the number of required BRBs by approximately 70%. For example, in one project the 7 conventional BRB frames were reduced down to 4 BRBM frames and the number of required BRBs were reduced from 56 to 16.*

employees to personally continue to learn about emerging practices in the industry and report back advancements to the firm. We also plan to engage our employees in conversations regarding sustainability by hosting a minimum of two presentations a year that will either highlight a webinar prepared externally or will update the firm on our progress in maintaining our commitment to SE 2050.

Our passion for educating our employees is not limited to current staff. We have already prepared and given a presentation to current employees regarding our role and commitment to this initiative. This presentation was recorded and will be adopted into our new employee on-boarding process so that all current and future employees understand our company's involvement and commitment to the initiative.

# Education

## EMBODIED CARBON ACTION PLAN

### EXTERNAL EDUCATION INITIATIVES

TSE will not only educate our employees, but will create robust external practices focused around educating our clients about our SE 2050 initiatives. We strongly believe that in order to reduce embodied carbon emissions by 2050, we need the support of our project owners, architects, and contractors. Early in the project phases, we will engage in open discussions regarding embodied carbon reduction methods and how we can incorporate these practices into our clients' buildings.

We are happy to educate and inform our clients about our firm's SE2050 goals. We have already partnered with like-minded architectural clients to give lunch and learn presentations to the joint staff of both offices focused around sustainability and reducing embodied carbon in both structural and architectural designs. We will continue to offer this resource to our clients and partners to promote sustainable building designs. Our goal is to continue hosting joint lunch-and-learn presentations by giving a minimum of two presentations a year to help inform and educate our trade partners around these topics.



### TSE WEBSITE AND MONTHLY NEWSLETTER

TSE will educate the general public regarding our SE 2050 initiatives. We will provide a page on our company's website that is dedicated solely to SE 2050. This page will:

- ✓ Include links to resources like the SE 2050 website
- ✓ Describe our company's involvement in the initiative
- ✓ Provide a point-of-contact at our firm to address questions regarding our commitment,
- ✓ Highlight projects we are using to study embodied carbon tracking.

Our quarterly newsletter will also describe our progress and share updates to a broader audience so that we can reach beyond our firm. Our goal is to spread awareness of this initiative to as many people as possible to encourage sustainable practices on a daily basis. Overall, TSE is excited to be a part of this initiative as we continue to educate our firm, clients, and the general public about the ways we can promote a more sustainable future.

For the Educational electives, we will pursue the following for our first year:

1. Share the SE 2050 Library of Resources with Technical Staff.
2. Share embodied Carbon Reduction Strategies with our firm as outlined in "Top 10 Carbon Reducing Actions for Structural Engineers" document produced by SE 2050.
3. Present the document "How to Calculate Embodied Carbon" to all technical staff.
4. Attend a presentation or demo of an LCA-based tool used to calculate embodied carbon.

*Left: Rammed-earth columns are used to meet the design goals of the architect and the client.*

# Carbon Tracking and Reporting

## EMBODIED CARBON ACTION PLAN

Tipping Structural Engineers strives to fill the role of trusted advisor to our clients and architectural partners. In that role, we rely on a data driven analysis of the multiple variables that overlap to inform a particular design or solution. In the same way that careful consideration of structural resilience, material efficiency, and project cost allow us to advise clients and shape project outcomes, a measured and vetted process for the accounting of embodied carbon allows us to identify the best reduction strategy for a given situation, integrating embodied energy reduction into every stage of the structural design process.

TSE has an established practice model to produce efficient, innovative designs and to find smart solutions to reduce both cost and embodied energy. The initial goal of our SE 2050 carbon tracking efforts will be to evaluate accounting methodologies and tracking tools to integrate carbon accounting as seamlessly as possible into our existing practice methods. We believe that an initial focus on rapid and accurate material quantity estimates, and the associated carbon estimates, during the conceptual phases of design represents one of the most effective opportunities to leverage smart structural design for maximum carbon reduction.

### EARLY DESIGN STAGE TRACKING

To this end, we are working to combine our established quantity estimating methods with simple spreadsheet based accounting tools, informed by pre-vetted regional EPD data, to produce a rapid carbon assessment engine that can easily and rapidly evaluate a wide range of conceptual structural options during early design. In the same way that “back of the envelope” calculations or “rough order of magnitude” cost estimates are applied during early design to quickly inform choices and steer design decisions, we are pairing a typical library of local EPDs with simple quantity estimating templates to effectively present embodied carbon as another critical design variable that must inform early design decisions for any successful project.

#### Primary Action Items:

- ✓ Training and knowledge transfer to junior staff of best practices around accurate early phase quantity estimating.
- ✓ Review of regional EPDs for common structural materials to pre-define an easy to access EPD library. Leading resources currently include the Carbon Leadership Forum and EC3.
- ✓ Integrate existing quantity estimating templates with EPD data to support rapid design iterations by staff. Current tools include in-house Excel spreadsheets and existing calculators created by EC3, SE2050, and IStructE.



*Left: In 2014, TSE was an early adopter of CLT gravity systems on this mixed-material residence.*



# Carbon Tracking and Reporting

## EMBODIED CARBON ACTION PLAN

### ONGOING DESIGN STAGE TRACKING AND VALIDATION

While a robust and nimble process to assess carbon content during early phase design maximizes opportunities for the most impactful reductions, a more detailed carbon accounting process must be deployed throughout the design process to confirm the efficacy of reduction strategies and design decisions. To this end, TSE is exploring methods to pair BIM modeling (i.e. Revit) with more developed LCA software (e.g. Beacon, IStructE), in order to quickly generate estimates of embodied structural carbon at any stage of design or construction.

We anticipate that this effort will initially focus on life cycle stages A1-A3 (material supply through manufacturing), as these are the most significant contributors to embodied carbon in typical structural systems. This is especially true for the rapid conceptual design process described above, when later stage inputs are often undefined.

As carbon estimating and accounting processes become more developed, we anticipate adding LCA stages A4-A5 to capture more nuanced impacts of project site and material sourcing decisions. In the same way that having a rapid and flexible carbon estimator during pre-design will inform design strategies with the widest impact, we believe that an integrated cradle to gate methodology (i.e. A1 to A5) embedded into default BIM modelling processes can impact carbon reduction recommendations and decisions around manufacturing processes, material sourcing, project specific specifications, and other decisions made during the pre-construction phase.

In the same way that early stage carbon estimating will inform effective reduction choices by the owner and the design team, accurate cradle to gate accounting prior to construction will inform effective carbon reduction choices by the construction team.

*Right: Green concrete specified on the SFPUC Headquarters decreased the project's carbon footprint by 7.4 million pounds of CO<sub>2</sub> emissions.*

### Primary Action Items:

- ✓ Train staff in the use of Beacon software to accurately quantify the embodied carbon in Revit design models.
- ✓ Integrate vetted local and regional EPD libraries into Beacon.
- ✓ Apply this tracking methodology to appropriate past projects to establish baseline carbon estimates that support the evaluation of new reduction strategies.
- ✓ Engage construction team partners during pre-con phases to leverage carbon estimates made during the design process into real embodied carbon reductions in the built environment.



# Embodied Carbon Reduction

## EMBODIED CARBON ACTION PLAN

Embodied carbon reduction of structural materials is the ultimate goal of the SE 2050 program. We will access the SE 2050 project database and other SE 2050 resources to identify and set strategies. We will share lessons learned and incite innovation. We will demonstrate leadership by applying and further developing best practices through actively collaborating with the design community. This is our opportunity to take more focused action and make greater impacts.

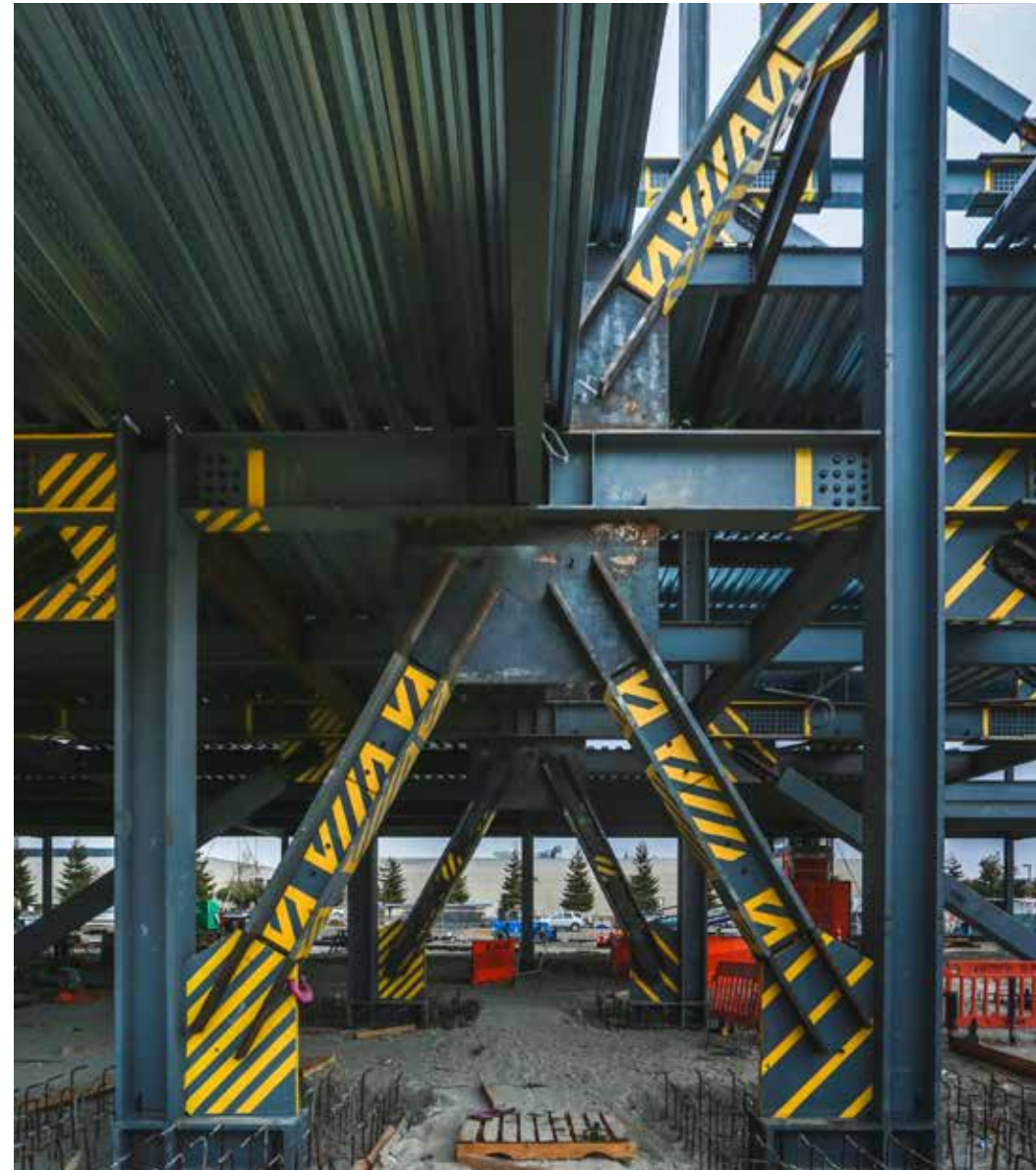
Recognizing that this is our initial ECAP, our qualitative goals for the first year are focused on education and we will progress our plan over the next six months to:

- ✓ Set an EC reduction goal for the following year (year two) with an implementation narrative.
- ✓ Provide a narrative about what we have learned about embodied carbon reduction in our first year describing successes and misses to help the program improve.

For the Embodied Carbon Reduction Strategy electives, we will pursue the following for our first year:

- ✓ Provide a project case study in our ECAP sharing embodied carbon lessons learned.
- ✓ Create a project-specific embodied carbon reduction plan.
- ✓ Collaborate with concrete suppliers to reduce embodied carbon in mix designs.
- ✓ Complete an embodied carbon comparison study during a project concept phase.

*Right: At 1951 Harbor Bay Parkway, BRB mast frames use significantly less material than a conventional structural steel system, while also providing enhanced redundancy, improved damage protection, and increased reliability.*



# Advocacy

## EMBODIED CARBON ACTION PLAN

Positive change will come with industry-wide adoption, recognizing that our impact reaches beyond any individual firm. We are planning to share our experience and knowledge within our firm, within the design community, and beyond. We are hosting internal webinars as lunch and learns, attending conferences, connecting with the SEI Sustainability Committee, and we are connecting with manufacturers and policy-makers.

Our advocacy goals include:

- ✓ boilerplate proposal language that declares our firm as a member of the SE 2050 commitment;
- ✓ promote SE 2050 in our external-facing communications;
- ✓ more effective early conversations with owners, architects, and contractors to advocate for more-sustainable design;
- ✓ incorporate additional language in our specifications targeting carbon reduction;
- ✓ teach innovative and sustainable design to the next generation of design professionals at institutions of higher education and industry events; and
- ✓ forge new relationships and strengthen existing relationships with like-minded design professionals, builders, and clients.

We will pursue the following advocacy electives for our first year:

- ✓ share our commitment to SE 2050 on your company website;
- ✓ provide a narrative of how we have encouraged industry and policy change incentivizing availability of low-carbon and carbon sequestration materials;
- ✓ start an embodied carbon community of practice or mentorship program in our office; and
- ✓ share our most informative case studies in our ECAP.



*Principal Leo Panian presented the benefits of green concrete to a multi-disciplinary audience at the 2020 Design Colloquium.*





# TIPPING

STRUCTURAL ENGINEERS

FOUNDED IN 1983 BY STEVEN B. TIPPING

STAFF OF 38

53 EXCELLENCE IN ENGINEERING AWARDS

1 LIVING BUILDINGS

21 LEED PLATINUM, 15 LEED GOLD BUILDINGS

7 NET-ZERO-ENERGY BUILDINGS

9 AIA COTE TOP TEN GREEN PROJECTS