AIA-CLF EMBODIED CARBON TOOLKIT FOR ARCHITECTS

PART III:

Strategies for reducing embodied carbon

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AIA

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Strategies to reduce embodied carbon

Broadly, there are a few types of strategies for reducing embodied carbon in buildings.

- Build less, reuse more by extending the life of existing buildings and materials.
- Substitute low-carbon materials for high-carbon ones.
- Build lighter and smarter with less of a given material (or floor area) to do the same work.
- Procure low(er)-carbon product selection.

We have organized these strategies into the following categories, ordered by priority in terms of project timeline and magnitude of potential emissions reductions:

» Design strategies

» Material and system selection strategies

» Specification and procurement strategies

Additionally, there are process strategies that are key to supporting architects in implementing reductions on projects, including:

- Use of LCA tools to track and measure embodied carbon reductions.
- Collaboration with engineers, owners, and builders.

Setting targets for reduction

Before picking which strategies to pursue, it can be helpful to set a reduction goal to align the design and construction team around.

Architects can often make large embodied carbon reductions with cost-neutral measures. A 2021 report from RMI found that case studies had embodied carbon savings of 24–46% at cost premiums of less than 1%.[1] Even greater reductions can be achieved through prioritizing design strategies early in a project to reduce embodied carbon.

Global organizations have set the following embodied carbon reductions targets to indicate which reductions need to be made on projects to reach net-zero as shown in table 1.

TABLE 1
Embodied carbon reduction targets

Organization	Target year			
	2025	**2030**	**2040**	**2050**
Arch 2030[2]	45%	65%	Net-zero	
LETI[3]	40%	60%	-	-
C40[4]	30%	50%	-	-
WGBC[5]	-	40%	-	Net-zero

Design strategies

Strategy	More information
Reuse/retrofit existing buildings	Architects can encourage reuse, renovation, and retrofitting part or all of an existing building, rather than demolishing to build anew. Case studies using WBLCA to compare the embodied carbon savings found that building reuse yields up to 44% less environmental impacts than new construction.[6] **Read more:** Zero Net Carbon Collaboration, AIA's Retrofitting Existing Buildings Guide, All for Reuse
Reduce [new] floor area	Architects can demonstrate opportunities for design and programmatic flexibility to reduce the indoor floor area required to meet the same program requirements, which translates to embodied carbon (and cost) savings.
Reduce below-grade construction	Architects can encourage reduction or elimination of below-grade parking or interior spaces. Subgrade construction (1) requires a large amount of concrete (a carbon-intensive material); and (2) causes carbon to be released from the soil during excavation, both of which can have large embodied carbon impacts.
Design lightweight, efficient structures	Structural design decisions—such as bay sizing, column and beam spacing, member cross sections, lightening slabs, and avoiding structural gymnastics (like cantilevers and transfer beams), etc.—can all result in large carbon *and* cost savings. These strategies require architects and engineers to coordinate to optimize the design. **Read more:** SE2050's Structural Engineering Institute Case Studies
Use WBLCA to optimize envelope design	Architects can use WBLCA (alongside energy modeling) to help assess the tradeoffs in embodied and operational carbon for envelope designs. Typically, lightweight envelope systems are likely to have the lowest embodied carbon (in addition to reducing the embodied carbon of the supporting structure). Durability is also key to extending the life of materials.

Material & system selection strategies

Strategy	More information
Select carbon-storing structural, envelope, insulation, & finish materials	Bio-based materials typically have lower upfront embodied carbon than conventional non-bio-based products and have the potential to store carbon over the life of the building. The availability of bio-based alternatives to conventional materials is increasing. Examples include mass timber, laminated bamboo, wood fiberboard, straw, clay-straw, hempcrete, cork, wool, linoleum, cork, and many more. In addition, some bio-based materials like mass timber are significantly lighter than their alternatives, reducing the load and size of supporting structural members. In some cases, the load may be decreased enough to allow for the preservation of an existing structure, unlocking additional savings from building reuse. **Read more:** WoodWorks, Builders for Climate Action's Carbon-positive Resources, Buildings as a Global Carbon Sink
Select MEP systems with low-carbon refrigerants	Refrigerant leakage is one of the biggest contributors to climate change within the building industry.[7] Architects can collaborate with engineers to use passive design strategies, select systems that use low-carbon refrigerants, and encourage clients to adopt building management practices to mitigate refrigerant leakage and ensure 100% refrigerant recovery. **Read more:** Integral Group's *Refrigerants + Environmental Impacts: A Best Practice Guide*
Choose insulation carefully	Selecting an insulation that balances operational and embodied carbon tradeoffs is key to achieving a total carbon balance for building. Generally, plastic/petrochemical-based insulations (rather than those nature-based materials) will have much higher embodied carbon. In particular, architects should avoid specifying HFC-containing rigid polyurethane spray foam, sealants, and XPS products that are being banned or significantly restricted in Canada and a growing number of U.S. states.[8] **Read more:** HFC bans by region and end-use product, Substitutes in Foam Blowing Agents
Select salvaged or refurbished materials	Design teams should consider material reuse opportunities across all parts of the project, from structure to interior finishes and furniture. Architects can: » Work with the building owner to reuse materials on-site or from other properties from the same owner; » Select salvaged materials; » Select refurbished materials, like furniture, that can have longer lives when refreshed.
Design for disassembly	Architects and engineers can collaborate to detail structural and envelope connections that can be easily disassembled and reused in future buildings. Where possible, avoid lamination or adhesion in assemblies (such as composite decks or hybrid mass timber and concrete assemblies) that prevent disassembly and reuse.

Strategy	More information
Avoid unrecyclable materials & coatings	Designing and specifying materials with end-of-life in mind increases the likelihood of reuse, and it reduces (or eliminates) end-of-life emissions from demolition, transportation, and waste processing. Architects can: » Avoid materials that could be difficult to recycle or reuse; » Avoid coatings, adhesives, and other composite connections that could prevent recycling.
Select finishes carefully	Architects and interior designers can collaborate to minimize finishes where not required for functional performance and select refurbished, carbon-storing, or otherwise lower-carbon finishes, particularly in spaces with high occupant turnover and frequent interior fit-outs where interiors add up to a large portion of embodied carbon over building life. **Read more:** Metropolis Climate Toolkit for Interior Design, CLF LCA of MEP Systems and Tenant Improvements

Specifications & procurement strategies

Strategy	More information
Integrate EPDs & GWP limits into project specifications	At a minimum, architects can use template language to incorporate requests for EPDs into their specifications as a part of submittals. For products where EPDs are more widely available, architects can integrate embodied carbon limits into the performance requirements for a product, requiring an EPD to document compliance with an embodied carbon limit (e.g., XX kg CO_2e/unit of material). **Read more:** OwnersCAN Embodied Carbon Action Plan
Optimize concrete specification & mix design	Concrete mix design has a huge impact on embodied carbon. Architects should collaborate with the structural engineer and contractor to ensure that reducing embodied carbon in concrete is a priority. Key strategies include: » Using performance-based specifications (rather than prescriptive requirements); » Minimizing the volume of portland cement by replacing portland cement with Type 1L cement, fly ash, slag, and other supplementary cementitious materials (SCMs), allowing for longer cure times (specifying strength at 56 days instead of 28 days to allow more time for strength gain) and other strategies. **Read more:** RMI's *Concrete Solutions Guide*, Breakthrough Energy's Corporate Climate Action Playbook (LinkedIn Case Study)
Source sustainable wood	The full life cycle of embodied carbon impacts and benefits of wood are often difficult to quantify because of complex supply chains and differing methods for calculating carbon benefits. Current procurement strategies include using reclaimed/salvaged wood, asking for chain-of-custody certificates or other supply chain transparency information, asking for sustainable forest management certifications (like FSC or SFI), and specifying wood that is locally harvested and harvested from working (not primary) forests. **Read more:** CLF's Wood Carbon Seminars, Climate-Smart Forestry.org
Use EPDs to identify lower-carbon facilities & products	Manufacturers vary in the sustainability of their facilities and sourcing practices. Two materials with the same performance may differ in their carbon footprints as a result of: » Energy source (fuel type/electricity grid mix) and plant efficiency in manufacturing facilities; » Product design to reduce the density or weight of a product without decreasing its function; » Lower-carbon ingredient sourcing, potentially through use of recycled, bio-based, or local ingredients. Due to the way products are specified and selected, EPDs are typically the best (or only) way for a project team to identify products made with the above strategies.
Evaluate cost & carbon in the bid process	Architects can encourage clients and contractors to evaluate carbon, in addition to cost and other criteria, as award criteria in the bid process for both private and public projects. **Read more:** OpenAir, ownersCAN Embodied Carbon Action Plan, Microsoft Case Study

Process strategies

Strategy	More information
Identify embodied carbon as a priority	In some cases, clients may have already identified embodied carbon as a priority. If not, architects can advocate to their client to set targets or set internal goals to track and reduce embodied carbon as part of a firm-wide strategy. **Read more:** CLF Embodied Carbon Toolkit for Building Owners
Set a project reduction target	Setting a project-wide embodied carbon reduction target can be a key first step in ensuring that embodied carbon is a cross-team priority. Architects have the opportunity to help align the design team around an embodied carbon reduction target.
Use WBLCA to evaluate design choices	Architects (or their consultants) are well-suited to lead the use of WBLCA tools throughout the design process to evaluate design options and system/material selections for carbon impacts, set and track project-specific reduction targets, and identify "hot spots" for emissions reductions. Learn more about WBLCA in *Part 2: Measuring Embodied Carbon*.
Use EPDs during procurement	Once a product type has been selected, architects should ask manufacturers to provide EPDs to help them select the lowest-carbon option. This can be done by asking product representatives in early stages of project design, searching the EC3 database, and specifying that EPDs must be submitted along with other product and material data.
Firm-wide commitments	Architecture firms can increase their impact and raise awareness across projects by adopting firm-wide goals and practices related to embodied carbon, rather than implementing only embodied carbon accounting and reductions on projects where they are specifically called out by the client. Cross-firm commitments may include firm-wide reduction targets, requiring WBLCA modeling on all projects of a certain size/type or pursuing the Building Life Cycle Impact Reduction credit on all LEEDv4 projects. **Read more:** 2030 Challenge Targets, SE2050's Structural Engineering Commitment, Miller Hull's Emission Zero

Endnotes

1 Rocky Mountain Institute. (2021). *Reducing Embodied Carbon in Buildings: Low-Cost, High-Value Opportunities*. https://rmi.org/insight/reducing-embodied-carbon-in-buildings

2 Architecture 2030. (n.d.). *2030 Challenge for Embodied Carbon*. Retrieved August 2021 from https://architecture2030.org/2030_challenges/embodied/

3 London Energy Transformation Initiative (LETI). (2020). *LETI Embodied Carbon Primer*. https://www.leti.london/ecp

4 C40 Cities. (n.d.). *Clean Construction Declaration*. Retrieved August 2021 from https://www.c40.org/clean-construction-declaration

5 World Green Building Council (WGBC). (2019). *Bringing Embodied Carbon Upfront*. https://worldgbc.org/news-media/bringing-embodied-carbon-upfront

6 National Trust for Historic Preservation. (2018). *The Greenest Building: Quantifying the Environmental Value of Building Reuse*. https://forum.savingplaces.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=5119e24d-ae4c-3402-7c8e-38a11a4fca12&forceDialog=0

7 Hawken, P. (2017). Drawdown: *The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*.

8 California Air Resources Board. (n.d.) *California Significant New Alternatives Policy (SNAP): How are Foams Affected?* Retrieved August 2021. https://ww2.arb.ca.gov/our-work/programs/california-significant-new-alternatives-policy-snap/foams