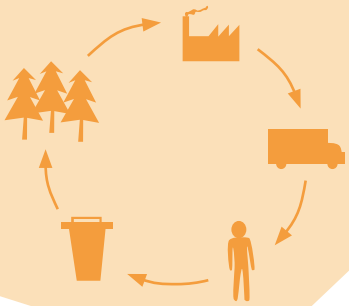


Embodied Carbon in Buildings
Project Checklist

introduction

getting started:

Reducing greenhouse gas emissions in new construction and renovation projects can be the work of a moment or a week of labor for a designer, can save or cost thousands for a client, and can significantly or marginally shape the environmental impact of a project. A small group of architects (including a specifier) discovered we had a shared goal—to simplify the process of reducing embodied carbon associated with our work. Found here is a broad spectrum of potential actions and tools by design phase, symbols denoting task duration, and flagged items that a designer can include regardless of client enthusiasm level.

Share this document with project team members including consultants at the beginning of each phase, highlight goals for the phase, and track your progress. Reach out with any suggested additions or feedback.

tools:

Planning / Programming:

- ☐ CARE (Carbon Avoided: Retrofit Estimator): https://caretool.org/
- ☐ EPIC (Early Phase Integrated Carbon Assessment): https://www.ehdd.com/design/epic

Whole Building LCA:

- ☐ Athena EcoCalculator: http://www.athenasmi.org/our-software-data/ecocalculator/
- ☐ BEAM (Building Emissions Accounting for Materials): https://www.buildersforclimateaction.org/beam-estimator.html
- ☐ One Click LCA: https://www.oneclicklca.com/
- ☐ Tally: https://www.choosetally.com/
- ☐ TallyCAT: https://www.buildingtransparency.org/tally/tallycat/

Assembly / Material:

- ☐ Beacon: https://www.thorntontomasetti.com/capability/beacon
- ☐ EC3 (Embodied Carbon in Construction Calculator): https://buildingtransparency.org/ec3/
- ☐ ECOM (Embodied Carbon Order of Magnitude): https://se2050.org/ecom-tool/
- ☐ Kaleidoscope: Embodied Carbon Design Tool: https://www.payette.com/kaleidoscope/

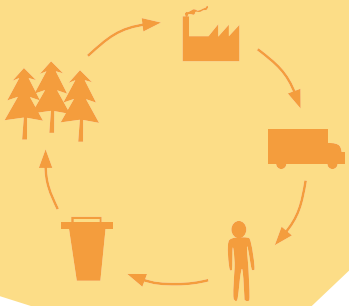
tools: *(continued)*

- ☐ Pathfinder: https://climatepositivedesign.com/pathfinder/
- ☐ ZGF's LCA Concrete Calculator: https://www.zgf.com/ideas/4127-download-zgf-s-lca-calculator-to-reduce-embodied-carbon-in-concrete

More: https://carbonleadershipforum.org/tools-for-measuring-embodied-carbon/

resources:

- ☐ Advanced House Framing: https://www.energy.gov/energysaver/advanced-house-framing
- ☐ AIA COTE Super Spreadsheet: https://content.aia.org/sites/default/files/2021-12/COTE_Super_Spreadsheet_Version_2.3.xlsx
- ☐ AIA Guide for Adaptability, Deconstruction, Reuse: https://www.aia.org/resources/6282663-design-for-adaptability-deconstruction-and
- ☐ Appendix 1 and 6 in LETI Embodied Carbon Primer: https://www.leti.london/ecp
- ☐ BuildingGreen EPD Quick-Start Guide: https://www.buildinggreen.com/infographic/epd-quick-start-guide-5-easy-steps
- ☐ Buy Clean California Act: https://www.dgs.ca.gov/PD/Resources/Page-Content/Procurement-Division-Resources-List-Folder/Buy-Clean-California-Act
- ☐ Carbon Smart Materials Palette: https://materialspalette.org/
- ☐ CLF Benchmarking: https://carbonleadershipforum.org/embodied-carbon-benchmark-study-data-visualization/
- ☐ CLF LCA Assessment of Buildings: A Simple Example: https://www.carbonleadershipforum.org/wp-content/uploads/2018/07/CLF-LCA-Practice-Guide-Gingerbread-House-Example-2018-07-09.pdf
- ☐ CLF LCA Practice Guide: https://carbonleadershipforum.org/lca-practice-guide/
- ☐ CLF LCA Timeline: https://carbonleadershipforum.org/wp-content/uploads/2019/05/2019.05.23-LCA-Timeline-Diagram-spread.pdf
- ☐ CLF Material Baselines: https://carbonleadershipforum.org/material-baselines/
- ☐ Demolition waste tracking: http://zerowastedesign.org
- ☐ EPD request letter: https://www.buildingtransparency.org/resources/ec3-downloads/
- ☐ ILFI Zero Carbon: https://living-future.org/zero-carbon-certification/
- ☐ mindfulMaterials: https://www.mindfulmaterials.com/
- ☐ SE 2050: https://se2050.org/



Embodied Carbon in Buildings Project Checklist

pre-design

highest impact:

- ☐ *Discuss:* Gauge client and team interest in embodied carbon.
  - High interest + capacity: Include whole-building life cycle analysis in scope of work; consider embodied carbon certification (ILFI Zero Carbon).
  - Moderate interest or capacity: include whole-building or targeted life cycle analysis in scope of work.
  - Low interest or capacity: Pursue flagged items.
  - Resource: Appendix 1 in LETI Embodied Carbon Primer
- ☐ *Reuse:* Analyze existing spaces to identify retrofit and renovation opportunities. Include embodied carbon in the equation when weighing adaptation of an existing building, space, or structure vs. new construction.
  - Resources: Athena EcoCalculator, CARE (Carbon Avoided: Retrofit Estimator) Tool, EPIC (Early Phase Integrated Carbon Assessment), BEAM (Building Emissions Accounting for Materials)
- ☐ *Target:* Establish a carbon target early and continue to refine. Architecture 2030 aims at a 40% reduction from industry average through 2025. For average values by building type, see AIA COTE Super Spreadsheet Tab 8: “Resources” (stay mindful of units) and CLF’s Benchmarking Data.

design approach:

- ☐ *Deliverable:* Incorporate embodied carbon reduction strategies in the end-of-phase report.
- ☐ *Project Delivery Method:* Make client aware of advantages to early contractor involvement relating to embodied carbon reductions.
- ☐ *Schedule:* Integrate embodied carbon evaluations into project schedule, including consultant coordination, through CA. Resource: CLF Timeline
- ☐ *Master Planning:* Identify paths toward building reuse/material salvage through material inventory. Maximize use of existing assets through upgrades and limit extent of new construction.
- ☐ *Programming:* Maximize flexible design principles such as room-sharing and multi-purpose spaces.
- ☐ *Programming*: Discuss strategies to extend time between refits.

Can be done without client permission

Short/quick task

Medium task

Long task

design approach: *(continued)*

- ☐ *Programming:* Perform utilization analysis to confirm accuracy of projected needs:
  - Collect scheduling data and conduct interviews with future users and registrar.
  - Consult space planning guidelines and perform benchmarking to right-size program.
- ☐ *Site Analysis:* Avoid or minimize site areas requiring soil stabilization or deep foundations. Involve geotechnical engineer early to strategize. Design for less cut and fill.
- ☐ *Site Analysis*: Right-size spaces, minimize envelope square footage and conditioned areas.
- ☐ *Costs:* Establish process to calculate monetary savings through embodied carbon strategies. *Example: Can you design to use less material?*
- ☐ *Lifespan/Efficiency:* Propose a construction approach suitable to the client's financial stability and the projected lifespan of the building. For temporary or short-life structures, plan for deconstruction. For tenant fit-out, design for flexibility and disassembly.
- ☐ *Goal:* Reduce business travel and commuting emissions from pre-design through construction admin.

material selection:

- ☐ *Materials:* Identify local, salvaged, and manufactured resources. Research materials that sequester carbon (wood, straw, rice hulls, bamboo, clay-straw, hempcrete or hemplime, cork, mycellium, sheep's wool). Resource: Carbon Smart Materials Palette

ask your consultants:

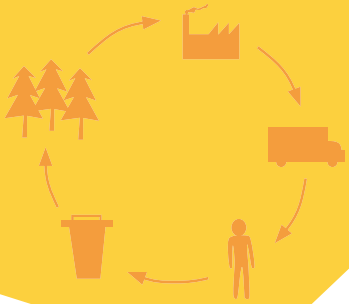
- ☐ *Structure:* Determine LCA scope for structural engineer. Consider fee impact of comparison of systems and details and economizing structure. Ask if they are part of SE 2050. Structural Tool: Beacon
- ☐ *Landscape:* Determine LCA scope for landscape architect. Landscape Tool: Pathfinder
- ☐ *M/E/P:* Determine LCA scope for engineers. Identify critical priorities including building electrification, next-generation refrigerants for chillers, reducing system sizing, and efficient use of materials. For a highly committed client, consider LCA calculations by weight where EPDs aren't available.
- ☐ *Civil*: Consider optimizing locations/capacity of existing utilities, minimize new roads/parking and other hard surfaces. If possible site near public transport.

Can be done without client permission

Short/quick task

Medium task

Long task



Embodied Carbon in Buildings
Project Checklist

concept design

highest impact:

- [ ] *Sustainability Charette:* Put embodied carbon on the agenda. Confirm if a prescriptive, limit-based (Buy Clean California Act), or performance-based (e.g. percentage reduction life cycle analysis - whole building or key components) approach is preferred. Include specification writer and structural engineer in the conversation. Resources: LCA Practice Guide and SE2050.
- [ ] *Tools:* Determine scope of LCA and identify the most appropriate tools to analyze progress of project at each phase of design. For new construction, begin at the massing model phase. For renovations, begin with existing conditions analysis and demolition scoping.
  - Whole Building LCA Tools: Athena, Tally, One Click LCA, TallyCAT
  - Assemblies and Material Tools: Kaleidoscope, BIM360 output to EC3, BEAM (Building Emissions Accounting for Materials)
  - Early Design: CARE (Carbon Avoided: Retrofit Estimator) Tool, EPIC (Early Phase Integrated Carbon Assessment)

design approach:

- [ ] *Education:* Educate team on embodied carbon essentials and EPD language. Resource: BuildingGreen EPD Quick-Start Guide
- [ ] *Massing studies:* Reduce foundation, site work, and floor slabs through massing studies.
- [ ] *Siting:* Investigate how to site new construction to minimize depth to bedrock and reduce excavation. Involve geotechnical engineer early.
- [ ] *Read:* Appendix 6: Rules of Thumb in the LETI Embodied Carbon Primer.

material selection:

- [ ] *Materials:* Review online libraries such as EC3 and mindful MATERIALS for product comparison capabilities, and develop a systematic approach to material specification. Chose materials with lower GWP.
- [ ] *Materials:* Focus on high impact items: structure, envelope, and common interior materials. Reduce material usage or use lower embodied carbon options.
- [ ] *Materials*: Use materials that naturally sequester carbon. Biologically natural materials such as wood, straw, rice hulls, clay-straw, hempcrete, cork, mycellium, and sheep's wool store carbon for their useful life. Resource: Carbon Smart Materials Palette

Can be done without client permission

Short/quick task

Medium task

Long task

CLF Carbon Leadership Forum Boston | *January 25, 2023*

material selection: *(continued)*

- ☐ *Lifespan/Efficiency:* For long lifespan buildings, select higher grade products to extend lifespan and reduce material replacement. Otherwise, consider designing structures and partitions for deconstruction; material reuse/recycling; and panelized construction with mechanical attachments. Resource: AIA Guide for Adaptability, Deconstruction, Reuse

ask your consultants:

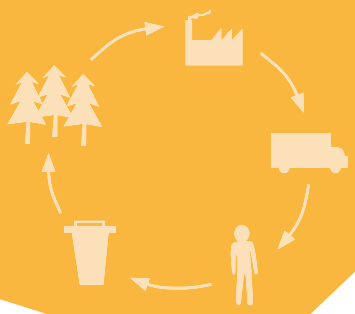
- ☐ *Structure:* Refer to SE2050 and CLF's Material Baselines to establish structural targets. Optimize column grid layout and beam spacing to minimize the total weight of materials used. Identify alternative approaches for high impact areas such as slabs and foundations.
- ☐ *M/E/P:* Discuss approaches to simplifying systems, right-sizing load calculations, and reducing equipment. For example, can point-of-use heating reduce DHW tank sizing?
- ☐ *Civil*: Consider optimizing locations/capacity of existing utilities, minimize new roads/parking and other hard surfaces. If possible site near public transport.
- ☐ *Tools:* Plan to analyze progress toward target and strategize approach to improve reductions throughout each phase.
  - Consultant Tools: Pathfinder for landscape design, Beacon or ECOM (Embodied Carbon Order of Magnitude) for structural design

Can be done without client permission

Short/quick task

Medium task

Long task



Embodied Carbon in Buildings
Project Checklist

schematic design

highest impact:

- ☐ *Process:* Perform a whole building LCA, use initial pass to identify Carbon "Hot Spots," and prioritize strategies for optimization. Focus on high-impact items such as structure, envelope, insulation, and common interior materials.
  - Resource: CLF's "Life Cycle Assessment of Buildings: A Simple Example"
  - Evaluate structural systems/types with SE2050
- ☐ *Target:* If aiming at a percentage of improvement of project embodied carbon, establish a baseline by the end of SD and target reduction goal.
  - Baseline option 1: WBLCA of early project model, assumptions must be based on standard design and material selection for project location and building type. Acceptable for LEED credit baseline.
  - Baseline option 2: If no early WBLCA model completed, reference average values by building type from AIA COTE Super Spreadsheet Tab 8: "Resources" (stay mindful of units) or CLF's Benchmarking Data.
- ☐ *Tools:* Analyze progress toward target and strategize approach to improve reductions throughout phase and future phases.
  - Whole Building LCA Tools: Athena, Tally, One Click LCA, TallyCAT
  - Assemblies and Material Tools: Kaleidoscope, BIM360 output to EC3, BEAM (Building Emissions Accounting for Materials)
  - Early Design: CARE (Carbon Avoided: Retrofit Estimator) Tool, EPIC (Early Phase Integrated Carbon Assessment)

design approach:

- ☐ *Siting:* Reduce excavation on site; avoid sites requiring soil stabilization or deep foundations; site building to minimize depth to bedrock. Involve geotechnical engineer early.
- ☐ *Envelope*: Evaluate options. For brick or stone, consider reducing material by reducing typical depth of specified material.
  - Tools: Athena, Kaleidoscope
- ☐ *Specification:* Set project goals for construction waste (including demolition). Include a specification section for demolition and construction waste management. Require CM/GC make a plan, track waste throughout project, create regular reports and end of project report.

Can be done without client permission

Short/quick task

Medium task

Long task

material selection:

- ☐ *Local:* Source local materials to reduce fossil fuels used in transportation to site, especially for heavy and high volume materials.
- ☐ *Wood:* Include Forest Stewardship Council (FSC) certified wood in outline specification.
- ☐ *Efficiency*: Design for efficient use of materials to reduce waste and cost. Talk with manufacturers to understand dimensions and constraints.
- ☐ *Flooring*: Specify a carbon neutral product (MindfulMaterials, Kaleidoscope and EC3 are useful resources). Select carbon sequestering products such as wood and bio-based flooring. Discuss maintenance.
- ☐ *FF&E*: Consider re-manufacturing old furniture to become new, and identify sources for refurbished furnishings.
- ☐ *EPDs*: Set target for number of products to have an EPD, and/or create list of products to select with an EPD. Use EC3 to set global warming potential target for select products.
- ☐ *Masonry*: Use low carbon alternatives such as straw bale and earth block construction.

ask your consultants:

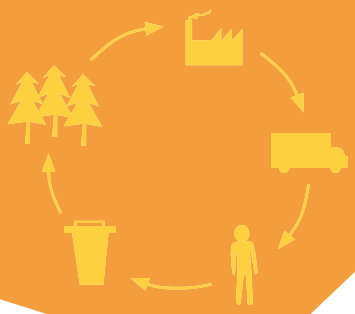
- ☐ *Structure*: Optimize column grid layout and beam spacing to minimize the total weight of materials used. Reduce dead loads, long spans, cantilevers, and transfer beams where possible.
- ☐ *Structure*: Compare system options and hybrid solutions. Use composite design, braced frames instead of moment frames.
- ☐ *Concrete*: Minimize cement use and maximize SCMs. Optimize strength for each component, do not over-design. Consider which concrete applications may use a slower cure time without impacting overall schedule, to reduce cement content.
  - *Resource*: SE2050 Concrete
  - *Tool*: ZGF's LCA Concrete Calculator
- ☐ *M/E/P:* Select systems that lower carbon. Consider natural ventilation/ hybrid solutions, ceiling fans to and expand temperature set-points, decouple heating/cooling system with ventilation to downsize ducts and ceiling heights, centrally locate ducts and equipment to minimize materials, glass sizing to minimize peak loads and equipment size.
- ☐ *Tools:* Analyze progress toward embodied carbon reduction target and strategize approach to improve reductions throughout phase.
  - Consultant Tools: Pathfinder for landscape design, Beacon or ECOM (Embodied Carbon Order of Magnitude) for structural design

Can be done without client permission

Short/quick task

Medium task

Long task



Embodied Carbon in Buildings
Project Checklist

design development

highest impact:

- ☐ *Process:* Focus on carbon reductions for high-impact "hot-spot" items such as structure, envelope, insulation, and common interior materials.
- ☐ *Tools:* Analyze progress toward embodied carbon reduction target and strategize approach to improve reductions throughout phase and future phases with targeted LCA studies to compare design choices.
  - Whole Building LCA Tools: Athena, Tally, One Click LCA, TallyCAT
  - Assemblies and Material Tools: Kaleidoscope, BIM360 output to EC3, BEAM (Building Emissions Accounting for Materials)
- ☐ *Material selection:* Select products and materials with circular economy (e.g. Cradle-to-Cradle Certified, take-back programs, zero waste, recycled content). Design for durability by specifying envelope materials and interior finishes with long warranties.

design approach:

- ☐ *Envelope*: Evaluate options. For brick or stone, consider reducing material by reducing typical depth of specified material.
  - Tools: Athena, Kaleidoscope
- ☐ *Efficiency:* Design for efficient use of materials to reduce waste and cost.
  - Learn material dimensions and constraints from manufacturers' reps.
  - Expose interior structure where viable, e.g. specify finish treatment for exposed concrete slab.
  - Maximize re-use or salvage of existing materials.
- ☐ *Design for deconstruction:* Design structures and partitions for deconstruction. Consider lightweight panelized construction with mechanical attachments.
- ☐ *Framing:* Optimize building framing to reduce over-designed wood stud walls through "Optimum Value Engineering" or "Advanced Framing Techniques" (e.g. incorporating single top plates or headers when viable, 24-in stud spacing, eliminating headers in non-load-bearing walls, using two studs at corners, etc.)
  - For details, visit the links section found at: https://www.energy.gov/energysaver/advanced-house-framing.

Can be done without client permission

Short/quick task

Medium task

Long task

design approach: *(continued)*

material selection:

- ☐ *Design for deconstruction:* Design for future recyclability; avoid coatings, treatments, and adhesives that compromise recyclability where possible. Have conversation with Owner about end of life recyclability; include in O&M manuals, and tenant guidelines.

- ☐ *Wood:* Include Forest Stewardship Council (FSC) certified wood in specifications.

- ☐ *Gypsum Wall Board and LGMF:* Review firm's standard acoustic partition types with gypsum board product reps with consideration for material efficiency.

- ☐ *Insulation:* Chose insulations that act as carbon sinks such as cellulose, cork, or lower carbon alternates like mineral wool. Limit the use of standard extruded polystyrene (XPS) to below grade locations or identify an alternative option or lower carbon manufacturer. Where a rigid plastic or spray-applied foam appears to be the best solution, require the use of water or hydrofluoro-olefin (HFO) blowing agent, and stay mindful of NFPA 285.

- ☐ *Masonry*: Specify CMU blocks, preferably low-carbon, in lieu of cast-in-place concrete. CMU uses less cement and sequesters carbon faster than concrete. Speak with block company reps to identify products with reduced embodied carbon content. Minimize use of steel reinforcement and grout, two high embodied carbon accessories to what is required structurally or for fire safety. Favor rebar with high recycled content.

- ☐ *Flooring*: Specify a carbon neutral product (MindfulMaterials, Kaleidoscope and EC3 are useful resources). Select carbon sequestering products such as wood and bio-based flooring, like linoleum, cork, bio-based polyurethane, and other bio-based tiles. Discuss maintenance. If selecting resilient flooring and carpet, look for product specific EPDs and high recycled content, from a company with take back program for the circular economy.

- ☐ *Acoustical Ceilings:* Select mineral fiber acoustic ceiling panels, with product specific EPDs and high recycled content, from a company with take back program for the circular economy.

- ☐ *FF&E*: Consider re-manufacturing old furniture to become new, and identify sources for refurbished furnishings.

- ☐ *EPDs:* Consider requiring EPDs showing compliance with limits set by Buy Clean California Act for maximum allowable GWP values for structural steel (hot-rolled sections, hollow structural sections, and plate), concrete reinforcing steel, flat glass, and mineral wool board insulation.

Can be done without client permission

Short/quick task

Medium task

Long task

material selection: *(continued)*

- ☐ *EPDs*: *Good:* Specify products with product-specific EPDs wherever possible; *Better:* Compare the global warming potential of products during product selection. *Best:* Include GWP limits in specifications. *Caveat:* EPDs are not yet available for every product type; use one of the forms located located here to request a manufacturer makes an EPD available: https://www.buildingtransparency.org/resources/ec3-downloads/
- ☐ *Goals:* Select materials manufactured with renewable energy; sourced locally, especially for heavy and high volume materials; with long warranties; salvaged for reuse; enabling future disassembly and re-use.

ask your consultants:

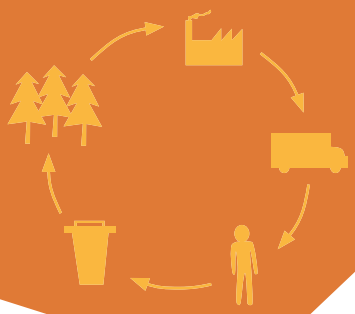
- ☐ *Structure*: Optimize column grid layout and beam spacing to minimize the total weight of materials used. Reduce dead loads, long spans, cantilevers, and transfer beams where possible.
- ☐ *Structure*: Optimize floor slab thickness to be as thin as possible and concrete mix in coordination with structural, acoustic, and fire resistance requirements. If using concrete, consider hollow core or voided concrete slabs to minimize total weight of concrete.
- ☐ *Concrete*: Minimize cement use and maximize SCMs. Optimize strength for each component, do not over-design. Consider which concrete applications may use a slower cure time without impacting overall schedule, to reduce cement content.
  - *Resource*: SE2050 Concrete
  - *Tool*: ZGF's LCA Concrete Calculator
- ☐ *Structure:* Design foundation to minimize excavation and material use.
- ☐ *Structure:* If using steel, use composite design, braced frames instead of moment frames.
- ☐ *M/E/P:* Select systems that lower carbon. Consider natural ventilation or hybrid solutions, ceiling fans to expand temperature set-points, decouple heating/cooling system with ventilation to downsize ducts and ceiling heights, centrally locate ducts and equipment to minimize materials, glass sizing to minimize peak loads and equipment size.
- ☐ *Fire Protection:* Improve the efficiency of the sprinkler layout.
- ☐ *Tools:* Analyze progress toward embodied carbon reduction target and strategize approach to improve reductions throughout phase.
  - Consultant Tools: Pathfinder for landscape design, Beacon or ECOM (Embodied Carbon Order of Magnitude) for structural design

Can be done without client permission

Short/quick task

Medium task

Long task



Embodied Carbon in Buildings
Project Checklist

construction documents

highest impact:

- [ ] *Process/Tools:* Analyze progress toward embodied carbon reduction target and strategize approach to improve reductions throughout phase with targed LCA studies to compare design choices.
  - Whole Building LCA Tools: Athena, Tally, One Click LCA, TallyCAT
  - Assemblies and Material Tools: Kaleidoscope, BIM360 output to EC3, BEAM (Building Emissions Accounting for Materials)
- [ ] *Efficiency:*
  - Detail for efficient use of materials to reduce waste and cost. Learn material dimensions and constraints from manufacturers' reps.
  - Expose interior structure where viable, e.g. specify finish treatment for exposed concrete slab.
  - Maximize re-use or salvage of existing materials.
- [ ] *Document:* At the end of CDs run a whole building LCA to document final embodied carbon intensity of project. Compare to baseline LCA or industry standard baselines for final percent reduction.

design approach:

- [ ] *Process:* Facilitate client consideration of reducing fossil fuel consumption during construction. Work with contract lawyer to determine what can be required, e.g. use of hybrid excavators, limiting generator use to 15 minutes per hour, establishing how schedules may be adjusted to reduce demand for temporary heating or cooling at peak times during extreme hot or cold weather events to limit project impact on electrical grid.
- [ ] *Design for deconstruction:* Detail structures and partitions for deconstruction. Consider lightweight panelized construction with mechanical attachments.
- [ ] *Design for deconstruction:* Design for future recyclability: avoid coatings, treatments, and adhesives that compromise recyclability where possible.

material selection:

- [ ] *Wood:* Specifiy Forest Stewardship Council (FSC) certified wood.

Can be done without client permission

Short/quick task

Medium task

Long task

material selection: *(continued)*

- ☐ *EPDs: Good:* Specify products with product-specific EPDs wherever possible. *Better:* Compare the GWP of products during product selection. *Best:* Include GWP limits in specifications. *Caveat*: EPDs are not yet available for every product type; use one of the forms located here to request a manufacturer makes an EPD available: https://www.buildingtransparency.org/resources/ec3-downloads/

- ☐ *Insulation:* Select long-term performance of insulations and drying capabilities. Consider insulations that act as carbon sinks such as cellulose or cork. Limit the use of extruded polystyrene (XPS) to below grade locations. Where a rigid plastic or spray-applied foam appears to be the best solution, require the use of water or hydrofluoro-olefin (HFO) blowing agent, if not required by local building codes, and stay mindful of NFPA 285.

- ☐ *Flooring:* Select carbon sequestering products such as wood and bio-based flooring, like linoleum, cork, biobased polyurethane, and other biobased tiles. Consider maintenance.

- ☐ *Masonry*: Minimize use of steel reinforcement and grout, two high embodied carbon accessories, to what is required structurally or for fire safety. Chose low carbon products.

- ☐ *Goals:* Select materials manufactured with renewable energy; sourced locally, especially for heavy and high volume materials; with long warranties; salvaged for reuse; enabling future disassembly and re-use.

ask your consultants:

- ☐ *Concrete*: Minimize cement use and maximize SCMs. Optimize strength for each component, do not over-design. Consider which concrete applications may use a slower cure time without impacting overall schedule, to reduce cement content.
  - *Resource*: SE2050 Concrete
  - *Tool*: ZGF's LCA Concrete Calculator

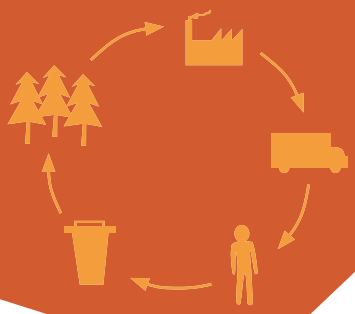
- ☐ *Steel:* Specify steel from electric arc furnaces (EAF), rather than Basic Oxygen Furnace (BOF), and/or steel made in the USA. EAFs make hot-rolled steel shapes like wide-flange members, angles, channel shapes, and rebar. A local manufacturer for bar and engineered bar stock often used in exposed steel, stairs, and exterior canopies is Nucor, with locations in Auburn, NY and Wallingford, CT.
  - Resources: SE2050 Steel

Can be done without client permission

Short/quick task

Medium task

Long task



Embodied Carbon in Buildings
Project Checklist

specifications

highest impact:

- ☐ *Process:* Communication is key in this team effort. Select products in coordination with specification writer and Owner's standards. Plan how EPD review will be integrated into the submittal process and submittal cover sheet.
- ☐ *Process:*
  - Coordinate with consultants on embodied carbon requirements for all spec sections.
  - Ask for EPDs for all products.
  - Include GWP limits in specifications. Focus on reducing GWP for high-impact materials such as structure, envelope, insulation, and interior finish surfaces.
  - Prioritize manufacturers that have green commitments.
  - Select products and materials with circular economy (e.g. Cradle-to-Cradle Certified, take-back programs, zero waste, recycled content).
  - Design for durability by specifying envelope materials and interior finishes with long warranties.

design approach:

- ☐ *Front End:* Work with client to establish local labor percentage goals to reduce commuting during CA.
- ☐ *Efficiency:* Communicate with spec writer:
  - Where manufacturers' material dimensions or other constraints are integral to design, and review offerings by specified manufacturers to confirm planned efficiencies can be achieved with specified manufacturers.
  - Where interior structure is exposed, and review specified finish treatments.
  - Where existing materials are salvaged, and review relevant provisions for protection, restoration, and reinstallation.
- ☐ *Process:* Review online libraries such as EC3 and mindfulMaterials for product comparison capabilities, and develop a systematic approach to material specification. Specify performance requirements.

Can be done without client permission

Short/quick task

Medium task

Long task

design approach: *(continued)*

- ☐ *Construction Waste Management:*
  - Set project goals for construction waste (including demoltion).
  - Include a specification section for demolition and construction waste management. Require CM/GC make a plan, track waste throughout project, create regular reports and end of project report.
  - Find a market for salvaged materials. Reach out early to demolition and waste subcontractors.
  - Track demolition and waste reduction throughout project, create monthly report and end of project report to account for waste reductions. See zerowastedesign.org for guidelines.

- ☐ *Envelopes / Division 07, 08:* For brick or stone, reduce material by reducing typical depth of specified material. Specify lower GWP insulation.
  - Tools: Athena, Kaleidoscope

- ☐ *Design for deconstruction / Divisions 06, 07, 09:* Consider future recyclability: avoid coatings, treatments, and adhesives that compromise recyclability where possible.

- ☐ *Framing:* Coordinate with structural engineer to optimize building framing to reduce overdesigned stud walls, especially for wood framing. Optimize framing through “Optimum Value Engineering” or “Advanced Framing Techniques” (e.g. incorporating single top plates, 24-in stud spacing, eliminating headers in non-load-bearing walls, using two studs at corners, etc.)

material selection:

- ☐ *EPDs / Divisions 03, 05, 07, 08:* Require EPDs showing compliance with limits set by Buy Clean California Act for maximum allowable GWP values for structural steel (hot-rolled sections, hollow structural sections, and plate), concrete reinforcing steel, flat glass, and mineral wool board insulation.

- ☐ *EPDs: Good:* Specify products with product-specific EPDs wherever possible. *Better:* Compare the GWP of products during product selection. *Best:* Include GWP limits in specifications. *Caveat*: EPDs are not yet available for every product type; use one of the forms located here to request a manufacturer makes an EPD available: https://www.buildingtransparency.org/resources/ec3-downloads/

- ☐ *Wood / Division 06:* Always specify Forest Stewardship Council (FSC) certified wood.

Can be done without client permission

Short/quick task

Medium task

Long task

material selection: *(continued)*

- ☐ *Lifespan / design for deconstruction:* For long lifespan buildings, select higher grade products to extend lifespan and reduce material replacement. Otherwise, design structures and partitions for deconstruction, material reuse/recycling, and panelized construction with mechanical attachments.
  - Resource: AIA Guide for Adaptability, Deconstruction, Reuse
- ☐ *Concrete:* Provide a performance-based specification for concrete, with different strengths required as appropriate. Minimize cement use and maximize SCMs.
  - For tips on reducing the cement content, direct structural engineers to tools including: SE2050 ECOM
  - *Tool*: ZGF's LCA Concrete Calculator
- ☐ *Steel:* Specify steel from electric arc furnaces (EAF) rather than basic oxygen furnaces (BOF), and/or steel made in the USA. EAFs make hot-rolled steel shapes like wide-flange members, angles, channel shapes, and rebar. In New England, a local manufacturer for bar and engineered bar stock often used in exposed steel, stairs, and exterior canopies is Nucor, with locations in Auburn, NY and Wallingford, CT.
- ☐ *Masonry:* Specify standard CMU blocks in lieu of cast-in-place concrete. CMU uses less cement and sequesters carbon faster than concrete. Speak with block company reps to identify products with reduced embodied carbon content. Identify approach to incorporating a GWP limit in the specification, and high recycled content for rebar. Consider alternatives such as straw bale and compressed earth block construction where suitable for the climate.
- ☐ *GWB:* Specify gypsum wall board (GWB) with lower global warming potential than industry standard. Example: USG's Sheetrock Brand EcoSmart gypsum wall board
- ☐ *Insulation:* Specify non-plastic insulations with lower embodied carbon, like cellulose, wood fiber, wool, and mineral wool. When specifying rigid plastic or spray-applied foam insulation, require the use of water or hydrofluoro-olefin (HFO) blowing agents.
- ☐ *Flooring:* Specify carbon sequestering products such as wood and bio-based flooring, like linoleum, cork, biobased polyurethane, and other biobased tiles. Require product specific EPDs where available.
- ☐ *Goals:* Select materials manufactured with renewable energy; sourced locally, especially for heavy and high volume materials; with long warranties; salvaged for reuse; enabling future disassembly and re-use.

Can be done without client permission

Short/quick task

Medium task

Long task