HUDSON PACIFIC PROPERTIES

LOW EMBODIED CARBON TENANT FIT-OUT GUIDE

2021

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Minimize the carbon impact of your office fit-out
with minimal impacts to your schedule and budget.

Interested? Read on!

1 Introduction: Carbon and Real Estate

At Hudson Pacific Properties, we recognize that commercial office landlords have a unique ability to drive sustainable behavior change at scale. As an industry leader in sustainability, we take this opportunity seriously and aim to engage our tenants in a variety of ways through Better Blueprint, our environmental, social and governance (ESG) platform. In 2019, we powered our entire operating portfolio with 100% renewable electricity, and in 2020 we achieved 100% carbon neutrality across all operations. Read more about Better Blueprint in our 2019 Corporate Responsibility Report.

We are proud of our achievements but recognize that there is much more work to do. We aim to engage, inspire, and support our tenants with the tools to reduce their environmental impacts wherever possible.

We've developed this guide to share our learnings and give our tenants insight and guidance when considering lower carbon materials in office fit-outs. By implementing the strategies presented in this guide you can reduce your carbon footprint with minimal impacts on budget and schedule, providing a win-win for your organization and the environment. Together we can change the market and help decarbonize real estate!

1.1 What is Embodied Carbon?

A material's embodied carbon is emitted during all aspects of the supply chain: raw material harvesting, manufacture, transportation and decommissioning. In real estate, most of these emissions happen before a building or office is occupied, depending on how and where materials are made.

Figure 1: Embodied vs Operational Carbon (image by S. Smedley)

Operational carbon is associated with the ongoing energy used to operate a building and has been the central focus of most decarbonization efforts. Hudson Pacific is proud to offset 100% of our operational carbon. However, it only accounts for the 'middle' stage of a project's entire life cycle and leaves out a significant piece of the carbon picture: the embodied carbon emitted before and after occupancy (see Appendix A for a breakdown of the embodied carbon footprint of each life cycle stage). Deep decarbonization therefore requires significant reductions in both operational and embodied carbon.

In the past, operational carbon far outweighed embodied carbon over the life cycle of a building. Today's buildings are more energy efficient and our energy systems emit less carbon per unit of energy. This means operational carbon is shrinking but embodied

carbon isn't (Figure 2). Embodied is therefore becoming an increasingly larger share of construction-based emissions. It is no longer enough to be energy efficient; we must also demand and purchase lower-carbon materials.

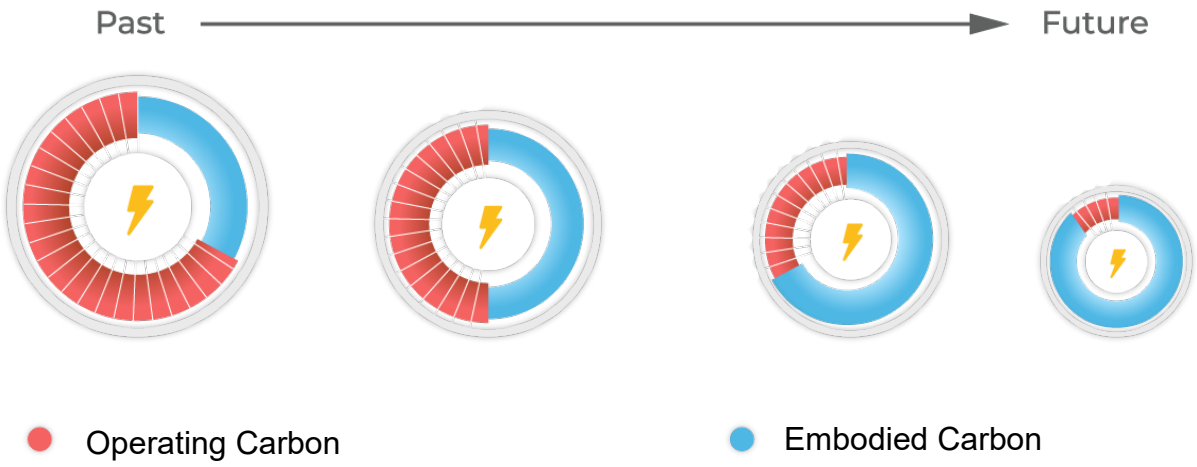


Figure 2: Operational carbon dropping over time while embodied carbon remains the same

2 How to Reduce Embodied Carbon

There are many ways to reduce the embodied carbon footprint of your office fit-out. When prioritized at the start of design, no-to-low cost options can often be found. A high-level overview of these measures is provided below, followed by some quick wins showcasing low-cost options for reducing embodied carbon.

1. Ask for Lower Carbon Options

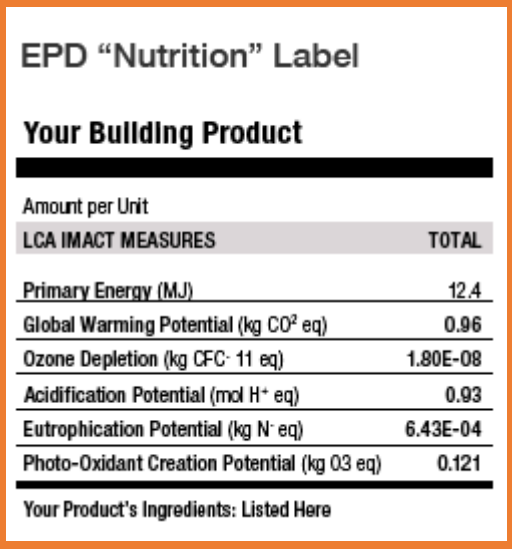
It's easy to ask your suppliers for low carbon materials (see Appendix C for a list of low-carbon suppliers to consider). In many cases, lower carbon options exist and can be price neutral. Ask your supplier to provide you with an Environmental Product Declaration (EPD) which details the carbon footprint of their product, and to provide recommendations for lower carbon alternatives that align with your design and cost specifications. See Section 2.1: Quick Wins – Steels studs, concrete, and carpet tiles and Appendix B for recommendations of how to integrate carbon-smart materials into your fit-out.

Environmental Product Declarations (EPDs)

You likely compare the price of alternative materials before you purchase one. Why not compare their carbon too? That's where EPDs come in.

EPDs are third-party verified documents that provide environmental information for a specific material. You can think of an EPD almost like a nutrition label that depicts the key impacts from a unit of that material.

See *Appendix D* for an example list of EPD sources. Ask your supplier for an EPD for all major materials you plan to purchase so that you can better understand their carbon footprint and compare the carbon footprint of alternatives.



EPD "Nutrition" Label

Your Building Product

Amount per Unit

LCA IMACT MEASURES	TOTAL
Primary Energy (MJ)	12.4
Global Warming Potential (kg CO^2 eq)	0.96
Ozone Depletion (kg CFC- 11 eq)	1.80E-08
Acidification Potential (mol H^+ eq)	0.93
Eutrophication Potential (kg N^- eq)	6.43E-04
Photo-Oxidant Creation Potential (kg 03 eq)	0.121

Your Product's Ingredients: Listed Here

2. Use Less Material

Perhaps the most straightforward method of reducing the carbon footprint of your project is to simply use less. Designing your space for material efficiency reduces the amount of materials in your fit-out, which saves both money and carbon. Many offices are now leaving ceilings exposed and concrete floors bare or polished with minimal coverings. Consider thinner walls, partitions, and finishes. All these measures save material, carbon and cost.

3. Increase Recycled Content

Prioritize materials made from recycled content. Recycled materials generally have less manufacture process, energy and carbon required than virgin material. Aluminum, steel and carpet are particularly well-suited to be specified as 'high recycled content', even up to 100% recycled content.

4. Increase Recyclability

Select materials – especially carpet tiles and ceiling tiles – that can be recycled (rather than landfilled) at end-of-life. Ask your supplier if they offer take-back programs for their materials and utilize these programs when you need to replace carpet and ceiling tiles due to normal wear-and-tear. This minimizes waste and carbon while supporting the transition to a circular economy.

5. Use Natural Materials

Select natural materials whenever possible, as they often have a smaller carbon footprint than engineered materials. Bio-based materials typically also remove carbon from the atmosphere. Examples of these 'carbon-smart' materials include:

- Wood for structural elements
- Natural stone for countertops
- Bamboo for flooring, roofing, and framing elements
- Hempcrete and sheep's wool for thermal and acoustic insulation

6. Choose Local Materials

Transportation of raw materials and finished products results in carbon emissions. Select locally produced materials to reduce transportation-based emissions. See Section 2.2: Co-benefits from reducing embodied carbon to learn more about benefits from choosing local materials.

7. Optimize Durability

The more durable a product or material, the longer it will function before it needs replacement. In many cases a more durable material can mean more carbon. This can be beneficial if it means the material will last longer and you can replace it less often.

Also consider if the material is likely to be replaced before the end of its useful life cycle for stylistic reasons. Many materials like wall coverings will be replaced for stylistic reasons far before they have reached the end of their functional life. It is therefore important to weigh major materials' durability (and thus carbon footprint) against their expected longevity for other reasons. Choosing an ultra-durable product doesn't make sense if it will be out of fashion and replaced in short order. If you know a specific product or use is likely to be changed in short order, consider something with less durability and perhaps a significantly lower carbon footprint.

8. Reuse

Reusing materials, partitions, furniture, and appliances can slash your embodied carbon footprint. It avoids the embodied carbon associated with new products' early life cycle stages. As a bonus, used products are often cost effective and help reduce landfill waste.

2.1 Quick wins – Steel studs, concrete, and carpet

See Appendix B for additional recommendations.

Choose Wood Wall Studs Instead of Steel

You might be surprised how much carbon can be saved by switching out one high-carbon material for a carbon-smart alternative. Something as minor and invisible as

switching your wall studs from steel to wood can have a sizeable impact on your project's carbon footprint. In some markets, wood studs can also be less expensive than steel studs.

In Hudson Pacific's office in Vancouver,[1] we found that making this change reduced our project's embodied carbon by nearly 20% and avoided more than 16 tonnes of CO_2- equivalent to taking 3.5 cars off the road for a year!

Low carbon concrete

If your project will use concrete, consider the cement you'll use. Portland-limestone cement (PLC) is an alternative to normal Portland cement. Both cost and perform the same, but PLC is 10% less carbon. Making the switch to PLC is an easy, low-cost solution that is being widely adopted. In fact, the Government of Canada is considering using PLC by default on future construction projects as a carbon reduction strategy.

Low Carbon Carpet Tiles

At Hudson Pacific's Bentall Centre in Vancouver, we dug deep into the carbon footprint of the materials we purchased. We used the EC3 tool (see right) to compare the carbon of major materials. We were able to identify carpet tiles that met all our needs and were also very low carbon resulting in a carbon savings of 85% (46 tonnes of CO_2e) against a third-party baseline. Table 1 shows some of our findings.

Embodied Carbon in Construction Calculator (EC3)

At Hudson's Bentall Centre in Vancouver, we calculated the embodied carbon reductions possible for major materials. To do this, we used the EC3 tool at www.buildingtransparency.org to compare the carbon footprint of specific materials under consideration against an industry average 'baseline'.

Table 1: Bentall Centre Carpet Tile Options Embodied Carbon Footprints

Product	Manufacturer	Carbon intensity ($kgCO_2e/m^2$)	Absolute carbon (tCO_2e)	Carbon reduction from baseline	Cost ($/m²)

[1] Roughly 8,600 square feet, or 800 square meters

Baseline (from EC3)	N/A	35.20	54	-	10-30 [2]
Community Collection, 5T321, Flat Weave	Shaw Contract	9.61	15	73%	25
World Woven One Collection Product: WW880	Interface	7.26	11	79%	40
World Woven One Collection (GlasBacRE) Product: WW870	Interface	5.11	8	85%	42

2.2 Co-benefits from reducing embodied carbon

While the main goal of minimizing the embodied carbon of a project may be to reduce greenhouse gas emissions to slow global climate change, doing so often brings other economic and social co-benefits including:

Supporting the local economy

Choosing materials produced locally reduces transportation-related carbon emissions. Specifying local can cut carbon while also boosting the local economy.

Green building certifications

Embodied carbon reductions are rewarded by many green building certification systems such as LEED and zero carbon standards. If your company is considering pursuing certification, reducing embodied carbon could secure you additional credits.

Enhanced brand recognition

Governments and industries aren't the only ones recognizing the importance of carbon reductions; customers and clients are as well. Reducing your carbon footprint will help you differentiate yourself from your competitors by demonstrating your leadership in climate-smart

[2] Based on research into typical commercial carpet costs

3 Costs and Benefits

You can often find lower carbon materials that cost less or are cost-neutral. For example, many wood products can cost less than steel alternatives and carry a significantly lower carbon footprint. At Bentall Centre we identified carbon-smart fit-out material alternatives without a significant premium as shown in Table 2.

Table 2: Bentall Centre Carbon-smart Material Options Embodied Carbon & Costs

Material	Product	Manufacturer	Cost ($/m^2)	Typical Cost Range for Material Type ($/m^2)	Carbon intensity ($kgCO_2e/m^2$)	Carbon reduction from baseline
Carpet Tile	Community, Ecoworx (5T321)	Shaw	25	10-30	9.61	73%
T Bar Ceiling Tile (ACT)	Mars Logix 88985	USG	48	30-60	6.48	76%
Ceramic Wall Tile	Trustone Series (TSWHS1224)	Confindustria Ceramica	35	40-70	10.50	20%
Ceramic Floor Tile	Station HD Porcelain Tile	Specified Product	35	40-70	13.14	0%

Tell your success story loud and proud! Stakeholders including clients, employees, and investors are all placing increasing value on climate-smart businesses. Post about your carbon reductions on your website and in your public facing reporting such as your Annual Report. Being a climate champion can unlock all kinds of value from recruiting and employee retention to access to funding and favorable financial terms.

4 Low-embodied Carbon Checklist

- ☐ Have you asked your suppliers for low-carbon options and/or EPDs? You can find many EPDs online and use them to calculate your project's embodied carbon footprint. Check out EC3 at www.buildingtransparency.org.

- ☐ Will your project use concrete? If so, consider Portland-limestone cement.

- ☐ Will your project use steel? If so, consider 100% recycled steel.

- ☐ Can you substitute natural materials in for traditional materials? Consider wood studs instead of steel.

- ☐ Are you ordering materials from abroad? Consider local suppliers for your major fit-out materials to minimize transportation-related emissions.

- ☐ Can you replace some materials with alternatives that have higher recycled content? Consider carpet tiles and steel.

- ☐ Can you revise your design to reduce the amount of materials needed for your fit-out? Consider exposed ceilings, concrete floors, and thin partitions.

- ☐ Have you chosen materials that are easily recyclable?

- ☐ Can you reuse materials, furniture and/or appliances from the previous tenant?

5 Additional Resources

Below is a list of some of the many resources available for those interested in learning more about embodied carbon.

Introductions to Embodied Carbon

- Embodied Carbon in the Built Environment - A Primer
- London Energy Transformation Initiative - Embodied Carbon Primer

Material-specific Resources

- Specifying Sustainable Concrete
- Mass Timber and Embodied Carbon (video)
- Construction Destruction: The hidden carbon costs of dirty steel

Guidance Documents/Tools

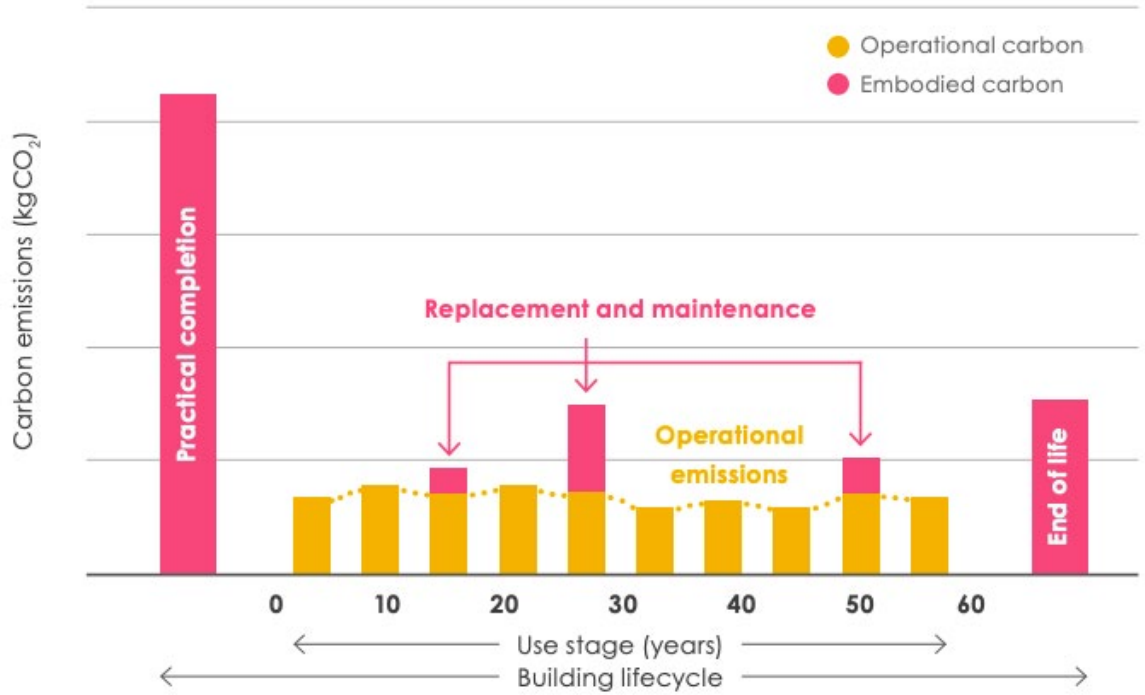
- Estimates of Embodied Carbon for Tenant Improvements in Commercial Office Buildings
    - Summary Document
    - Full Report
- Embodied Carbon Guidance: A Resource for Calculating and Reducing Embodied Carbon
- Athena Guide to Whole-Building LCA in Green Building Programs
- Embodied Carbon: Developing a Client Brief

Embodied Carbon Construction Calculator (EC3) Tool[3] (requires free registration)

[3] For a demo of the EC3 Tool, see here.

This guide was created for Hudson Pacific Properties by Mantle314, North America's largest dedicated climate change consultancy. You can find out more at www.mantle314.

Appendix A - Breakdown of Embodied Carbon Life Cycle Stages



As depicted above, the carbon emissions of a building happen at different stages throughout the building's life cycle.

These stages are broken down as follows:

- Upfront embodied carbon emissions happen by "practical completion" of the project. These emissions are associated with the harvest, manufacture, transportation, and assembly of the initial construction materials;
- Emissions associated with manufacture of replacement materials of major systems like windows and roofing, represented by "replacement and maintenance" and happen at various times throughout a building's life cycle;
- Emissions from demolition and decommissioning, represented by "end of life".

- Operational carbon emissions occur annually, and are associated with ongoing systems such as heating, cooling, ventilation, lighting, and plug loads.

Appendix B - Carbon-smart Considerations for Typical Fit-out Materials[4]

This table presents strategies to reduce the embodied carbon of typical fit-out materials.

Material	Attributes
Concrete	• Less cement = less carbon. Ask for concrete with less cement where possible • Specify Portland Limestone Cement (PLC) instead of Portland cement • Maximize supplementary cementitious materials (SCMs) in your mix • Understand the mix options available to your local suppliers and source your aggregate locally • Consider 56 or later day-strength on parts of your project where early strength isn't required (longer strength requirements allows for less cement to be used) • Encourage your concrete suppliers to use carbon sequestration (CO_2 injection) methods where possible
Steel	• Specify high-recycled content or 100% recycled steel • Specify steel made from North American mills (typically less carbon than foreign steel) • Consider replacing steel with other materials, for example changing wall studs from steel to wood • Opt for steel produced in electric arc furnaces (EAFs) as opposed to basic oxygen furnaces (BOFs)
Wood	• Specify reclaimed wood products • Only specify timber from sustainably managed forests; there are certifications to help you identify suppliers of this type of timber, such as the FSC certification • Specify fast-growing wood

[4] This information in this table was pulled from the Carbon Smart Materials Palette (CSMP) with some additions from Mantle314. More information on each material and greater details on their attributes can be found on the CSMP website: https://materialspalette.org/palette/

Material	Attributes
	• Specify wood products manufactured without the use of fossil fuels or greenhouse gas-emitting biofuels • Don't use wood from old growth forests • Specify wood products with minimal processing • Where this does not conflict with any of the above, opt for locally-sourced wood products
Insulation	• Specify insulation materials that naturally sequester carbon like bio-based options • Specify blown-in insulation instead of rigid and spray foam insulations • Avoid Expanded Polystyrene (EPS), Extruded Polystyrene (XPS), Polyisocyanurate (Polyiso), Structurally Insulated Panel Systems (SIPS) with foam insulation, and spray foam, where climate allows
Carpet	• Specify carpet tile rather than broadloom or sheet carpet to reduce installation and maintenance waste • Specify carpet with high recycled plastic content, especially in nylon face fiber • Specify carpet with solution-dyed nylon yarn • Balance embodied carbon with durability - while carpets made from commodity plastic fibers (PET/polyester, polypropylene, etc.) have a lower initial carbon footprint than recycled nylon (an engineering plastic), they are often not durable enough for most commercial environments and can wear down quickly, requiring frequent replacement • Avoid plush, high-pile carpet with virgin nylon fiber • Glue-down only when necessary for safety or performance. Carpet that is not permanently affixed to the floor will also be easier to maintain, selectively replace, rearrange, reuse, and recycle, extending the useful life of the carpet • Consider eliminating floor finishes where appropriate. Using structural materials (i.e. exposed concrete slabs or mass timber floor panels) as finish materials eliminates the embodied carbon emissions of additional architectural finishes
Gypsum board	• Specify lightweight gypsum board • Use the thinnest gypsum board necessary

Material	Attributes
	• Consider lower embodied carbon panel products where appropriate. Gypsum board alternatives that utilize compressed agricultural fibers (CAF) may present a low-carbon alternative to standard gypsum board

Appendix C - List of Low-carbon Suppliers (updated June 2020)

The embodied carbon impact of common construction materials was sourced from the Embodied Carbon in Construction Calculator (EC3) tool. For each material type, the two manufacturers with the lowest embodied carbon product(s), as identified in EC3, are shown in Table 2. EC3 is a living / evergreen tool, which means that the low-carbon manufacturers identified are subject to change as additional data becomes available and therefore the below manufacturers should be confirmed and/or updated by checking the tool.

Sample sizes have been added, which represent the number of Environmental Product Declarations (EPD) available under each material type. This was added to illustrate the varying data availability for each material type and highlight instances where limited data is available for some products (e.g., wood and flooring).

For more information, please visit https://www.buildingtransparency.org/en/

Table 3: Manufacturers with lowest carbon products as per Embodied Carbon in Construction Calculator (EC3) Tool

Material	Material Sub-Category	Manufacturers with the lowest carbon products (Location of product)	Sample size (EPDs in dataset)	Notes
Gypsum	N/A	1. USG (Pennsylvania) 2. CertainTeed Gypsum Inc. (North America)	72	CertainTeed is being considered for Bentall Centre Repositioning project
Ceiling Panel	N/A	1. Rockfon (Poland) or Ecophon AB (Sweden) 2. USG (US)	136	- USG is being considered for Bentall Centre Repositioning project. - Additional transportation emissions for shipping international products should be considered. For this material type, even when transportation emissions from Europe are included, these European manufacturers are still lower carbon than USG ceiling panels.
Carpet	Tile	1. Interface (Georgia) 2. EF Contract (Georgia)	132	Interface is being considered for Bentall Centre Repositioning project

Material	Material Sub-Category	Manufacturers with the lowest carbon products (Location of product)	Sample size (EPDs in dataset)	Notes
	Broadloom	1. Mohawk Industries (Georgia) 2. EF Contract (Georgia)	16	
Steel Rebar	N/A	1. Nucor (Washington) 2. Farwest Steel Corp. (Oregon)	87	Gerdau Long Steel North America and Addison Construction Supply Inc. (Tacoma, WA) also have relatively low-carbon steel rebar.
Structural Steel	General (incl. Hollow)	1. Arcelor Mittal (Luxembourg) 2. Celsa Steel (UK)	14	- Gerdau Long Steel North America also offers relatively low carbon structural steel products - Additional transportation emissions for shipping international products should be considered. For this material type, even when transportation emissions from Europe are included, these European manufacturers are still lower carbon than Gerdau Long Steel North American structural steel. - Only two EPDs on hollow structural steel are from Tata Steel (UK)
	Hot-rolled	1. Gerdau Long Steel North America 2. CMC (USA)	21	
Cold formed steel	N/A	1. MBA Building Supplies (TX, PA, AL & IL) 2. CEMCO (California)	17	Includes products, such as steel studs.
Aluminium	N/A	1. Alcoa (Quebec) 2. Armstrong Ceilings (Georgia & California)	9	
Wood	Dimensional lumber	1. Roseburg Forest Products (Oregon) 2. BSW Timber Ltd, James Jones & Sons Ltd & John Gordon and Son Ltd (UK)	4	
	Sheets and boards	1. Roseburg Forest Products (Oregon) 2. Medite Europe DAC (Ireland)	7	
	Engineered timber	1. Nordic Structures (Quebec) 2. Roseburg Forest Products (Oregon)	4	

Material	Material Sub-Category	Manufacturers with the lowest carbon products (Location of product)	Sample size (EPDs in dataset)	Notes
	Wood I-joists	1. Roseburg Forest Products (Oregon) 2. Redbuilt (Oregon)	3	
Insulation	Boards	1. Rockwool International (British Columbia) 2. Kingspan (Ontario)	243	BASF Corporation (US & Mexico) also offers relatively low-carbon insulation boards
	Blankets	1. CertainTeed Gypsum inc. (Alberta) 2. Knauf Insulation (Illinois)	118	Owen's Corning (North America) also offers relatively low-carbon insulation blankets
	Blown	1. Knauf Insulation (California) 2. Owens Corning (Alberta)	19	
	Sprayed	1. International Cellulose Corporation (Texas)	2	
Glass panes	N/A	1. Vitro Architectural Glass (Oregon) 2. Guardian Glass (USA)	9	
Resilient Flooring Tiles	Composition Cork Tile	1. Amorim Revestimentos (Spain)	1	
	Lineoleum Tile	Data unavailable	0	EC3 may add data for lineoleum tile in the future.
	Rigid Core LVT	1. Decoria Materials (Shanghai) 2. Zhejiang Kingdom Plastics Industry Co. (China)	3	
	Vinyl Composition Tile (VCT)	TAJ Flooring (South Korea)	1	
	Luxury Vinyl Tile (LVT)	1. NOX Corporation (South Korea) 2. Mohawk Flooring or EF Contract (Georgia)	73	Additional transportation emissions for shipping international products should be considered. For this material type, even when transportation emissions from South Korea are included it is still lower carbon than the LVT made in Georgia.
	Rubber Tile	1. Ecore International (Pennsylvania) 2. Roppe Corporation (Ohio)	15	

Material	Material Sub-Category	Manufacturers with the lowest carbon products (Location of product)	Sample size (EPDs in dataset)	Notes
Resilient Flooring Sheets	Linoleum Sheet	OzoTec (South Korea)	1	
	Hetergeneous Sheet	Data unavailable	0	EC3 may add data for heterogenous sheets in the future.
	Homogeneous Sheet	Tarkett (Georgia, USA)	1	
	Rubber Sheet	1. Ecore International (Pennsylvania) 2. Nora Systems (New Hampshire)	4	
Other Flooring	Concrete Panel	Tate Access Floors Inc. (Ontario)	1	

Appendix D - EPD Resources (updated July 2020)

Program operators are responsible for registering EPDs and managing EPD databases. This table provides a list of North America's current program operators and links to their EPD registries. Please note that this is not a comprehensive list as Program Operators can change and new EPDs are constantly being developed.

Program Operator	Product Category	EPD Registry Link (if available)
ASTM International	Building and Construction Materials	https://www.astm.org/CERTIFICATION/EpdAndPCRs.html
Carbon Leadership Forum	Building and Construction Materials	N/A
Canadian Standards Association (CSA)	Building and Construction Materials	https://www.csaregistries.ca/epd/epd_listing_e.cfm
Environdec*	Multiple	https://www.environdec.com/EPD-Search/
FP Innovations	Wood Products	https://cwc.ca/why-build-with-wood/sustainable/green/epds/
ICCES	Wood Products	N/A
National Asphalt Pavement Association	Asphalt Mixtures	https://asphaltepd.org/published/

National Ready Mix Concrete Association	Concrete	https://www.nrmca.org/sustainability/EPDProgram/#ProductSpecificEPDs
NSF	Building and Construction Materials	http://info.nsf.org/Certified/Sustain/listings.asp?ProdCat=EPD
SCS Global Services	Building and Construction Materials	https://www.scsglobalservices.com/certified-green-products-guide?program=192
Sustainable Minds***	Multiple	https://www.transparencycatalog.com/
UL*	Multiple	https://spot.ul.com/

* These links are to very large registries that require entering a search item and filtering by 'EPD' to display relevant results.
** This is a comprehensive EPD database, so there is likely overlap between this registry and some of the other registries in this table.