2021 Carbon Leadership Forum

Material Baselines

BASELINE REPORT | JANUARY 2021

Carbon Leadership Forum

ABOUT THE CARBON LEADERSHIP FORUM

The Carbon Leadership Forum is a non-profit industry-academic collaborative at the University of Washington. We are architects, engineers, contractors, material suppliers, building owners, and policymakers who work collaboratively, pioneering research, creating resources, and incubating member-led initiatives for greatest collective impact. Our goal is to accelerate transformation of the building sector to radically reduce and ultimately eliminate the embodied carbon in building materials and construction.

AUTHORS

The research team from the Carbon Leadership Forum at the University of Washington College of Built Environments:

- Stephanie Carlisle, Senior Researcher, Carbon Leadership Forum
- Brook Waldman, Researcher, Carbon Leadership Forum
- Meghan Lewis, Senior Researcher, Carbon Leadership Forum
- Kathrina Simonen, Executive Director, Carbon Leadership Forum

ACKNOWLEDGMENTS

The research team would like to thank Building Transparency and the Pankow Foundation for supporting this research. This document supersedes the EC3 Beta Baseline documents published in 2019 and updated in 2020. We would like to thank Stacy Smedly, Phil Northcott, and Vaclav Hasik from Building Transparency for their review and work on the EC3 tool.

CITATION

Carlisle, S., Waldman, B., Lewis, M., and Simonen, K. (2021). 2021 Carbon Leadership Forum Material Baseline Report. Carbon Leadership Forum, University of Washington. Seattle, WA.

COPYRIGHT

Cover image by Katernya Babaieva
https://www.pexels.com/photo/man-standing-near-fire-3361235/

INTRODUCTION

The building industry has an essential role to play in tackling climate change associated with building construction and materials manufacturing. Our present understanding of the importance of embodied carbon has been enabled by rigorous quantitative modeling that tracks carbon emissions across the full life of materials and products, using life cycle assessment (LCA).[1] In recent years, the building industry has adopted LCA as the globally accepted method for evaluating and communicating environmental impacts, and applied these methods to the study of materials, products, and assemblies. LCA data and results are essential for guiding science-based efforts to decarbonize buildings and infrastructure.

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

The Carbon Leadership Forum is part of a broad movement working to drive down the embodied carbon of building materials and products by encouraging the disclosure of high-quality embodied carbon data by manufacturers. It is essential that designers, owners, and policymakers have access to verified, third-party reviewed and published data on building materials and products in order to facilitate procurement decisions, set decarbonization targets, and inform design. One tool for achieving this goal has been the collection and use of Environmental Product Declarations (EPDs) to inform decision-making. EPDs are third party-verified documents based on LCA models, written in conformance with international standards, that report the environmental impacts of a product. These declarations can be used to track supply chain-specific product data and compare products if the products are functionally equivalent and have aligned scopes.

The development of material baselines originated in support of the Embodied Carbon in Construction Calculator (EC3). The EC3 Baselines were originally published in 2019. This document supersedes the baselines dated May 2020. The EC3 tool and its open-access database of digital EPDs is one source for accessing and evaluating available EPDs and the relative carbon impacts that they report. Such databases support designers, owners, and policymakers in selecting low-carbon products during procurement and design. These databases are dynamic, updated constantly as new products are added and upstream data on key processes, such as carbon intensity of regional electricity grids, are revised.

Environmentmental Product Declaration (EPD)

EPDs are third party-verified documents based on LCA models, written in conformance with international standards, that report the environmental impacts of a product.

In order to set achievable targets, it is necessary to have a baseline from which to compare products within a material or product category. This document provides an overview of the 2021 CLF Material Baselines published by the Carbon Leadership Forum. This report constitutes an update to 2019 Beta Baselines with improved data sourcing, citation, and categories.

BASELINE DEFINITION AND USE

Globally, the availability of embodied carbon data for materials and products is growing as more and more manufacturers produce EPDs and make the environmental impacts of their supply chains known. Still, the publication of EPDs and other carbon disclosure is voluntary and its adoption has been uneven. Because not all products or manufacturers are currently represented in public databases such as EC3, the ranges reported will very likely continue to be low estimates of the full material supply chain's carbon impacts, representing manufacturers that have voluntarily chosen to disclose the carbon footprint of their products. Due to the dynamic nature of these datasets, users have identified the need for a static baseline to compare results against, and against which they can set measurable targets.

Presently, the CLF publishes three figures in order to provide a picture of variability within a product category, according to the best publicly available data: High, Median, and Low. **The baselines are intended to give a rough order of magnitude of embodied carbon impacts per category reflecting the significant variability of product manufacturing and uncertainty of LCA data available.** Collectively, these values represent the expected range of embodied carbon impacts for most products in their category, taking variability and uncertainty into account.

The **CLF Baseline** represents a conservative, or "high" estimate for embodied carbon in a product category. This value is intended to give a rough order of magnitude of embodied carbon impacts and represents a high estimate of the embodied carbon footprint of a product if no effort is made to choose a low-carbon alternative. Most products in the category will fall below this threshold. This CLF Baseline number can be considered a good starting point from which to develop carbon caps or reductions. For categories in which there are sufficient product-specific EPDs, the CLF Baseline is tied to the 80th percentile value of the category, (i.e., the point where 80% of the results have values below this number), as represented in the EC3 database of published, peer-reviewed EPD results. The CLF Baseline is shown within the EC3 tool for all public categories.

The **CLF "Typical" Estimate** represents the median performance of products contained within a category. This value is tied to an Industry-Average EPD, if one is available and valid at the time of publication. This number can be seen as a typical estimate for the category, representing standard manufacturing practice. As such, it is appropriate to use this number as a rough estimate before products have been selected, or as a default value for broad product comparisons. Industry-Average EPDs are developed by industry associations representing multiple manufacturers and locations and declare the environmental impacts associated with an "average product" in a clearly defined sector or geographic area.[2] Products covered in an Industry-Average EPD follow the same Product Category Rule (PCR) and have the same declared unit. All Industry-Average EPDs referenced by the

What is a baseline?

A baseline is a static reference against which to compare progress towards a goal. Baseline data enables the tracking of changes or improvements over time and across projects.

2. International EPD System, "Sector or Industry Average EPD," https://epdweb3.azurewebsites.net/all-about-epds/what-is-an-epd

EC3 database are published, peer-reviewed documents based on rigorous LCA models.

The **CLF "Achievable" Estimate** represents an achievable target, or a low value for the category, whereby at least 20% of products meeting the specification are better than this value. For categories in which more than 20 product-specific EPDs are available and where these products represent the range of materials and production expected within the category, this value has been based on 20th percentile figures in the EC3 tool and noted in the data citation. Products that meet this threshold could credibly be considered very low-carbon materials compared to those of similar performance and function.

DATA SOURCES

These estimates are created based upon a range of available data including:

- Industry-average EPDs, representing production-weighted averages for a material category.
- Distribution of impacts from all known product-specific EPDs for a product category, at the time of publication.
- Peer-reviewed, published reports on carbon impacts and variability within a material category.
- The Inventory of Carbon and Energy which includes embodied carbon ranges of key materials.

Given that most material product categories currently lack industry-wide, embodied carbon data that disclose variability across supply chains and manufacturers, the Carbon Leadership Forum is estimating these baselines using one of three methods, depending on the quality of available data for a material product category:

Method 1: If industry-specific data exist regarding the range of the emissions in this product category, the ranges used will be extracted from that data and the source will be listed as a primary citation. For example, the CLF Ready Mixed Concrete figures draw from an Industry-Average EPD and also a recently published National and Regional Industry-Average Benchmark Report which discloses variability across regions and mixes per strength class. Both sources of data are published by the National Ready Mixed Concrete Association.[4]

Method 2: If a material category has many EPDs (more than 20 product-specific EPDs are present in the EC3 database), the results of the EC3 tool will be directly used to estimate the baselines. In this case, "High" and "Low" figures were extracted directly from the EC3 tool representing the 80th percentile of the distribution of the EPD data in the EC3 tool at the time of publication. Note that this is an approximation of the 80th percentile due to the lack of data on industry production volumes, which would be needed to make a production-weighted calculation. This method is more appropriate for material

3. Circular Ecology, Embodied energy and carbon - The ICE database V3.0 Beta, 2019. http://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html#.XdDAHVdKjD4

4. National Ready Mixed Concrete Association (NRMCA). (2020). Appendix D: NRMCA Member National and Regional LCA Benchmark (Industry Average) Report - Version 3. Athena Sustainable Materials Institute. Retrieved from https://www.nrmca.org/wp-content/uploads/2020/10/NRMCA_REGIONAL_BENCHMARK_April2020.pdf

   National Ready Mixed Concrete Association (NRMCA). (2019). NRMCA Member Industry-Average EPD for Ready Mixed Concrete. NSF. Retrieved from https://www.nrmca.org/wp-content/uploads/2020/02/EPD10080.pdf

categories such as carpet or gypsum board, for which there are hundreds of EPDs representing multiple suppliers and a broad range of product types.

Method 3: If a material category has very few EPDs (less than 20) in the EC3 database or if the available EPDs are understood to not represent the full breadth of the market, then the Carbon Leadership Forum will estimate the baseline to be the midpoint between an industry average value and an industry-high value for the material category or product sub-type. The industry-average or industry-high values will be obtained from industry-wide EPDs or the Inventory of Carbon and Energy (ICE). This method is used for categories such as wood products in which very few EPDs have been published and in which variability has not been disclosed in industry-wide EPDs or other public reports.

None of these methods are statistically exact. Due to the current scarcity of information on industry production quantities and the unequal representation of high- and low-carbon products in the current selection of available EPDs, these methods are approximations that may be used until better data exists. Ideally this data would be provided directly from LCA studies that have access to the industry-specific production and emissions data. The Carbon Leadership Forum has made every effort to be fully transparent about the source and quality of data used to establish these baselines on a category-by-category basis.

SCOPE

Baseline figures are representative of North American manufacturing, acknowledging global trade. The CLF Baselines represent Product Stage (A1-A3) carbon impacts — that is, the cradle-to-gate impacts from raw material extraction to manufacturing. This cradle-to-gate scope comprises the majority of embodied carbon impacts for the majority of materials, and is consistent with the scope of most product-specific EPDs.[5] Additional impacts from transportation and installation (A4-A5) can also be considered in upfront embodied carbon and can be significant for some material categories, but are not included in the benchmark figures, as they are not not currently required by many Product Category Rules for publication in Environmental Product Declarations (EPDs). As this data becomes available, it will be important for A4 and A5 impacts to be integrated into procurement decisions.

5. Carbon Leadership Forum, "Life Cycle Assessment of Buildings: A Practice Guide," 2018, https://doi.org/http://hdl.handle.net/1773/41885.

COMPARABILITY

Life Cycle Assessment is a comparative practice, and it is important for users to follow best practice in making appropriate comparisons between products and materials. The CLF Baselines represents a rough estimate of a product category's carbon footprint. However, in order to make material comparisons, it is incumbent upon a user to assure that the products, materials, or assemblies are functionally equivalent — i.e., that they serve the same purpose and meet the same performance standards within the building

design. Please refer to the *Embodied Carbon in the EC3 Tool: Methodology Report* for future guidance on making appropriate comparisons.

Additionally, the EPDs in each of the broad categories include many unique products with unique performance characteristics that are not always possible to identify from the data currently included in EPDs. Better descriptions of the performance characteristics and creation of a digital EPD system could help overcome these limits.

The CLF Baseline figures do not represent the impacts associated with the full life cycle of a building assembly. Only the Product Stage (A1-A3) is included, as this represents the scope of most EPDs in the EC3 database. Baseline figures, therefore, do not include Transportation to site (A4), Use (B1-B3) or End-of-Life (C1-C4) stages. Care should be taken when comparing materials or products with different use or end-of-life scenarios. In order to make cross-category comparisons or to assess a whole building over its full life span, more rigorous modeling must be conducted using a whole building LCA (WBLCA) tool with a full cradle-to-grave scope.

FUTURE UPDATES

The Carbon Leadership Forum is publishing these baseline figures in support of the EC3 tool and will continue to update them annually. New baseline categories will be added as more EPDs are published and data availability improves in both scope and resolution. These baselines will also be used to test and improve the methods used to assess embodied carbon of materials and products. If you have suggestions or feedback on how we might improve these baselines, please contact CLFdataEC3@uw.edu

ENGAGE AND HELP REFINE

We are actively looking for help in refining these methods, and look forward to helping accelerate the standardization of calculation and reporting of uncertainty and variability in EPDs in order to improve the quality, quantity, and accessibility of embodied carbon data. If you are interested in engaging in the technical committees supporting methodology and data development, please email CLFdataEC3@uw.edu for updates and forums for discussion, feedback, and continued research.

2021 BASELINE FIGURES

		2021 CLF BASELINES kg CO2e per declared unit					
Category	**Subtype**	**Achieveable (Low)**	**Typical (Median)**	**Baseline (High)**	**Declared unit**	**Method**	**Data Source**
CONCRETE							
Ready Mixed Concrete	0-2500 psi (0-17.2 Mpa)	190	266	**340**	m3	1	All baselines based on industry data from National Ready Mixed Concrete Association (NRMCA). Typical = NRMCA USA benchmark value per strength class (NRMCA Member National and Regional LCA Benchmark (Industry Average) Report – Version 3, Feb 2020 update, Table E1); Low = NRMCA minimum value per strength class (NRMCA IW-EPD Ready Mixed Concrete, 2019); high = NRMCA max value per strength class (NRMCA IW-EPD Ready Mixed Concrete, 2019) + uncertainty factor due to cement variation (Building Transparency analysis). Note that the NRMCA Industry Average EPD provides data for strength ranges (e.g., 3001 - 4000 psi), while the NRMCA Benchmark Report provides data for specific strength values (e.g., 4000 psi).
	2501-3000 psi (17.2-20.7 MPa)	210	291	**380**	m3	1	
	3001-4000 psi (20.7-27.6 MPa)	260	343	**470**	m3	1	
	4001-5000 psi (27.6-34.5 MPa)	320	406	**580**	m3	1	
	5001-6000 psi (34.5-41.4 MPa)	330	429	**610**	m3	1	
	6001-8000 psi (41.3-55.1 MPa)	380	498	**710**	m3	1	
	>8001 psi (>55.1 MPa)	411	535	**710**	m3	1	
Slurry	Flowable Fill	90	170	**230**	m3	2	Flowable fill is not represented in a separate IW-EPD. Low = EC3 20th percentile Jan 2021; Typical = EC3 50th percentile; High = EC3 calculated 80th percentile Jan 2021 drawn from 7 product-specific EPDs and an uncertainty factor to aproximate manufacturing variability. Low/Ave/High based on EC3 data Dec 2020, for slurry mixes of <=1200 psi. NRMCA IW-EPD numbers for lightweight concrete across strengths represented in dataset.
	Structural Grout	270	458	**620**	m3	2	Low/Typ/High based on EC3 data Dec 2020 , for slurry mixes of >=1200 psi. NRMCA IW-EPD numbers for lightweight concrete across strengths represented in dataset.
Shotcrete	*match ready mix values*						
STEEL							
Rebar		0.8	0.98	**1.7**	kg	2	Typical = IW-EPD Fabricated Steel Reinforcement (CSRI,2017); Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from IW-EPD and 64 product-specific EPDs.
Plate Steel		1.0	1.47	**3.0**	kg	3	Typical = IW-EPD Fabricated Steel Plate (AISC, 2016c); Low = CLF 2019 beta low value; High = CLF 2019 beta high value = Rough approximation of midpoint between industry average value and estimated global high based on ICE database v3.0.
Structural Steel	Hollow Sections	1.5	2.39	**3.0**	kg	3	Typical = IW-EPD Fabricated Hollow Structural Sections (AISC, 2016a); Low = CLF beta low value; High = adjusted to reflect similar ranges as other steel products on this list due to shortage of available data.
Structural Steel	Hot-Rolled Sections	0.8	1.16	**1.7**	kg	2	Typical = IW-EPD Fabricated Hot Rolled Structural Sections (AISC, 2016b); Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from IW-EPD and 34 product-specific EPDs.
Cold Formed Steel	Framing	1.5	2.28	**3.0**	kg	3	Typical = IW-EPD Cold-Formed Steel Studs and Track manufactured in U.S. and Canada (SRI, 2016); Low = CLF 2019 beta low value; High = CLF 2019 beta high value. These numbers match the 20% and 80% figures in EC3 as of Jan 2021, drawn from IW-EPD and 4 product-specific EPDs.
Prefabricated Assemblies	Open-web steel joists	0.7	1.38	**2.5**	kg		Typical = IW-EPD Open-web steel joists (SJI, 2015); Low = CLF 2019 beta low value; High = CLF 2019 beta high value
WOOD & COMPOSITES							
Dimension Lumber	Wood framing	50	63	**100**	m3	3	Typical = IW-EPD Softwood lumber (AWC/CWC, 2020); Low = CLF 2019 beta low value; High = CLF 2019 beta high value
Sheathing Panels	Plywood & OSB Sheathing	200	230	**400**	m3	2	Typical = IW-EPD NA Softwood Plywood (AWC/CWC,2020) and NA Oriented Strand Board (AWC/CWC,2020); Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from 24 product-specific EPDs and 2 IW-EPDs .
Sheathing Panels	Glass Mat Gypsum Sheathing	2600	4170	**5800**	1000 m2	2	Typical = IW-EPD Glass Mat Gypsum Panels 1/2" and 5/8" (GA, 2016); Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from 1 IW-EPD and 40 product-specific EPDs.
Prefabricated Wood Products	Wood I-joists	1.0	1.97	**6.0**	m	3	Typical = IW-EPD NA Wood I-Joist (AWC/CWC, 2020); Low = CLF 2019 beta low value; High = CLF 2019 beta high value
Composite Lumber	LSL/LVL/PSL	230	361	**400**	m3	3	Typical = IW-EPD Laminated Veneer Lumber (AWC/CWC, 2020); Low = CLF 2019 beta low value; High = CLF 2019 beta high value.
Mass Timber	GLT/CLT/DLT/NLT	104	137	**200**	m3	3	Typical = IW-EPD NA Glue Laminated Timber (AWC/CWC, 2020); Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from 7 product-specific EPDs and an uncertainty factor to aproximate manufacturing variability.

		2021 CLF BASELINES kg CO2e per declared unit					
Category	Subtype	**Achieveable (Low)**	**Typical (Median)**	**Baseline (High)**	**Declared unit**	**Method**	**Data Source**
INSULATION							
Insulation by form	Board	**2**	**10**	**20**	m2-Rsi	2	This category inculdes several material options, incuding a variety of foam and fiber insulation products. Therefore, no single IW-EPD is available that covers this range of products. Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from 271 product-specific EPDs and two IW-EPDs in the EC3 database. IW-EPDs include: Mineral Wool Insulation Board (NAIMA, 2018) and EPS Foam Insulation (EPS Industry Alliance, 2017).
	Blanket	0.5	**3**	**4**	m2-Rsi	2	This category inculdes several material options, including cellulose, fiberglass, light mineral wool, and others. No single industry-wide EPD is presently available that covers this range of products. Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from 56 product-specific EPDs plus uncertainty factor (1.25).
	Foamed-in-Place	2.33	**9**	**20**	m2-Rsi	3	Typical = IW-EPD Spray Polyurethane Foam Insulation (HFC) and Spray Polyurethane Foam Insulation (HF0) (Spray Polyurethane Foam Alliance, 2018). Note; this benchmark value covers both oc and cc spray foam products). Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 plus uncertainty factor (1.25).
	Blown	1	2	**3**	m2-Rsi	3	This category inculdes several material options, including loose blown cellulose, and fiberglass. No single industry-wide EPD is presently available that covers this range of products. Low/Typical/High values based on 8 product and IW-EPDs in EC3 database plus uncertainty factor to express manufacturing variability. IW-EPD represented in dataset: Conventional Loose-Fill Cellulose Insulation (CIMA/CIMAC, 2019)
FINISHES							
	Gypsum Board	2500	2980	**4500**	1000 m2	2	Typical = IW-EPD Type X Conventional Gypsum Board (Gypsum Association, 2020), based on a 5/8" gypsum board product; Low = EC3 20th percentile Jan 2021; High = EC3 calculated 80th percentile Jan 2021 drawn from IW-EPD and 85 product-specific EPDs.
	Acoustical Ceiling Tiles	6	11	**14**	m2	2	No industry-wide EPD is presently available for this product. Low = EC3 20th percentile, Ave = EC3 50th percentile, High = EC3 calculated 80th percentile Jan 2021 drawn from 157 product-specific EPDs.
	Resilient Flooring	6	13	**20**	m2	2	Ave = unweighted ave of 6 available industry EPDs; low/high = 20th/80th percentiles (including burden of doubt) from EC3 Jan 2021.
	Carpet	6	11	**20**	m2	2	No industry-wide EPD is presently available for this product. Low = EC3 20th percentile, Typical = EC3 50th percentile, High = EC3 calculated 80th percentile Jan 2021 drawn from 274 product-specific EPDs plus uncertainty factor (1.25).
COMMUNICATIONS							
Data Cabling	Data Cabling, non-fiber	0.30	0.50	**0.70**	m	2	No industry-wide EPD is presently available for this product. Low = EC3 20th percentile, Typical = EC3 50th percentile, High = EC3 calculated 80th percentile Jan 2021 drawn from 314 product-specific EPDs.
	Data Cabling, fiber	2.00	8.60	**16.50**	m	2	No industry-wide EPD is presently available for this product. Low = EC3 20th percentile, Typical = EC3 50th percentile, High = EC3 calculated 80th percentile Jan 2021 drawn from 37 product-specific EPDs.
BULK MATERIALS							
	Flat Glass	1.2	1.4	**2.3**	kg	2	Low = CLF beta low; Typical = industry wide EPD; high = EC3 80th percentile (including burden of doubt) Jan 2021

Note: for a full list of EPDs referenced above see following page.

DATA REFERENCES

American Institute of Steel Construction (AISC). (2016a). Environmental Product Declaration - Fabricated Hollow Structural Steel Sections. UL Environment. Retrieved from https://www.aisc.org/globalassets/why-steel/103.1_aisc_epd_fab-hss.pdf

American Institute of Steel Construction (AISC). (2016b). Environmental Product Declaration - Fabricated Hot-Rolled Structural Sections. UL Environment. Retrieved from https://www.aisc.org/globalassets/why-steel/102.1_aisc_epd_-fab-sections_20160331.pdf

American Institute of Steel Construction (AISC). (2016c). Environmental Product Declaration - Fabricated Steel Plate. UL Environment. Retrieved from https://www.aisc.org/globalassets/why-steel/101.1_aisc_epd_-fab-plate-20160331.pdf

American Wood Council (AWC). (2020). Environmental Product Declaration - Redwood Lumber. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_RedwoodLumber_20200605.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2016a). Environmental Product Declaration - North American Cellulosic Fiberboard. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC-EPD-CFB-1602.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2016b). Environmental Product Declaration - North American Laminated Strand Lumber. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC-EPD-LSL-1602.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2020a). Environmental Product Declaration - North American Glue Laminated Timber. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_NorthAmericanGluedLaminatedTimber_20200605.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2020b). Environmental Product Declaration - North American I-joists. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_NorthAmericanWoodIJoists_20200605.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2020c). Environmental Product Declaration - North American Oriented Strand Board. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_NorthAmericanOrientedStrandBoard_20200605.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2020d). Environmental Product Declaration - North American Laminated Veneer Lumber. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_NorthAmericanLaminatedVeneerLumber_20200605.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2020e). Environmental Product Declaration - North American Softwood Lumber. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_NorthAmericanSoftwoodLumber_20200605.pdf

American Wood Council (AWC), & Canadian Wood Council (CWC). (2020f). Environmental Product Declaration - North American Softwood Plywood. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_NorthAmericanSoftwoodPlywood_20200605.pdf

Cellulose Insulation Manufacturers Association (CIMA). (2019). Industry-wide Type III EPD - Conventional Loose-Fill Cellulose Insulation. NSF. Retrieved from https://www.cellulose.org/images/EPD_CIMA_CIMAC_Conventional_Loose-Fill_Cellulose_Insulation_JAN20-1.pdf

Circular Ecology. (2019) Inventory of Carbon and Energy (ICE) Database V3.0. Retrieved from https://circularecology.com/embodied-carbon-footprint-database.html

Composite Panel Association (CPA). (2016). Environmental Product Declaration - North American Hardboard. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC-EPD-Hardboard-1608.pdf

Composite Panel Association (CPA). (2018a). Environmental Product Declaration - North American Medium Density Fiberboard. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC-EPD-MDF-190501.pdf

Composite Panel Association (CPA). (2018b). Environmental Product Declaration - North American Particleboard. UL Environment. Retrieved from https://www.awc.org/pdf/greenbuilding/epd/AWC-EPD-Particleboard-1902.pdf

Concrete Reinforcing Steel Institute (CRSI). (2017). Environmental Product Declaration - Fabricated Steel Reinforcement. ASTM International. Retrieved from https://www.crsi.org/cfcs/cmsIT/baseComponents/fileManagerProxy.cfc?method=GetFile&fileID=83406608-EB89-B478-754D2D0CD-BC4D12A

EPS Industry Alliance (EPS-IA). (2017). Environmental Product Declaration - EPS Insulation. UL Environment. Retrieved from https://epsindustry.org/sites/default/files/EPS Insulation EPD.pdf

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020a). Environmental Product Declaration for: Cork floor tiles according to EN 12104.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020b). Environmental Product Declaration for: Cushioned polyvinyl chloride floor coverings according to EN ISO 26986.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020c). Environmental Product Declaration for: Glued down LVT according to EN ISO 10582.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020d). Environmental Product Declaration for: Heterogeneous polyvinyl chloride floor coverings according to EN ISO 10582.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020e). Environmental Product Declaration for: Homogeneous and heterogeneous smooth rubber floor coverings according to EN 1817.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020f). Environmental Product Declaration for: Homogeneous polyvinyl chloride floor coverings according to EN ISO 10581.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020g). Environmental Product Declaration for: Plain and decorative linoleum according to EN ISO 24011.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020h). Environmental Product Declaration for: Polyvinyl chloride floor coverings with foam layer according to EN 651.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020i). Environmental Product Declaration for: Polyvinyl chloride floorcoverings with enhanced slip resistance (Safety Flooring) according to EN 13845.

European Resilient Flooring Manufacturers' Institute (ERFMI). (2020j). Environmental Product Declaration for: Semi flexible LVT floating floor with mechanical locking according to EN ISO 10582.

Gypsum Association (GA). (2016). Industry Average EPD for Glass Mat Gypsum Panels. NSF. Retrieved from https://gypsum.org/download/10491/

Gypsum Association (GA). (2020). Industry Average EPD for 5/8" Type X Conventional Gypsum Board. NSF. Retrieved from https://gypsum.org/download/14311/

National Glass Association (NGA). (2019). Environmental Product Declaration - Flat Glass. ASTM International. Retrieved from https://www.glass.org/sites/default/files/2019-12/NGA_EPD_2019_12_16_signed.pdf

National Ready Mixed Concrete Association (NRMCA). (2019). NRMCA Member Industry-Average EPD for Ready Mixed Concrete. NSF. Retrieved from https://www.nrmca.org/wp-content/uploads/2020/02/EPD10080.pdf

National Ready Mixed Concrete Association (NRMCA). (2020). Appendix D: NRMCA Member National and Regional LCA Benchmark (Industry Average) Report - Version 3. Athena Sustainable Materials Institute. Retrieved from https://www.nrmca.org/wp-content/uploads/2020/10/NRMCA_REGIONAL_BENCHMARK_April2020.pdf

North American Insulation Manufacturers Association (NAIMA). (2018a). Environmental Product Declaration - Mineral Wool Heavy Density Board. UL Environment. Retrieved from https://spot.ul.com/main-app/products/detail/5ad1ea7255b0e-82d946a4dae?page_type=Products Catalog

North American Insulation Manufacturers Association (NAIMA). (2018b). Environmental Product Declaration - Mineral Wool Light Density Board. UL Environment. Retrieved from https://spot.ul.com/main-app/products/detail/5ad1ea7255b0e-82d946a4dad?page_type=Products Catalog

North American Insulation Manufacturers Association (NAIMA). (2018c). Environmental Product Declaration - Mineral Wool Loose Fill. UL Environment. Retrieved from https://spot.ul.com/main-app/products/detail/5ad1ea7255b0e82d946a4dac?page_type=Products Catalog

NSF International. (2014). Product Category Rule for Environmental Product Declarations GANA PCR for Flat Glass. Retrieved from https://d2evkimvhatqav.cloudfront.net/documents/GANA_Flat_Glass_PCR.pdf

Polyisocyanurate Insulation Manufacturers Association (PIMA). (2020a). Environmental Product Declaration - Polyiso Roof Insulation Boards. NSF. Retrieved from https://www.polyiso.org/page/EPDs

Polyisocyanurate Insulation Manufacturers Association (PIMA). (2020b). Environmental Product Declaration - Polyiso Wall Insulation Boards. NSF. Retrieved from https://www.polyiso.org/page/EPDs

Quebec Wood Export Bureau (QWEB). (2019). Prefabricated light wood frame roof truss Environmental Product Declaration. CSA Group. Retrieved from http://www.quebecwoodexport.com/images/stories/pdf/QWEB_EPD_RoofTruss.pdf

Resilient Floor Covering Institute (RFCI). (2019a). Industry Wide Environmental Product Declaration - Heterogeneous Vinyl Flooring. UL Environment. Retrieved from https://rfci.com/wp-content/uploads/2019/01/101.1_RFCI_EPD_Heterogeneous-Vinyl-Flooring.pdf

Resilient Floor Covering Institute (RFCI). (2019b). Industry Wide Environmental Product Declaration - Homogeneous Vinyl Flooring. UL Environment. Retrieved from https://rfci.com/wp-content/uploads/2019/01/102.1_RFCI_EPD_Homogeneous-Vinyl-Flooring.pdf

Resilient Floor Covering Institute (RFCI). (2019c). Industry Wide Environmental Product Declaration - Rigid Core Flooring. UL Environment. Retrieved from https://rfci.com/wp-content/uploads/2019/01/103.1_RFCI_EPD_Rigid-Core-Flooring.pdf

Resilient Floor Covering Institute (RFCI). (2019d). Industry Wide Environmental Product Declaration - Rubber Flooring. UL Environment. Retrieved from https://rfci.com/wp-content/uploads/2019/01/104.1_RFCI_EPD_Rubber-Flooring.pdf

Resilient Floor Covering Institute (RFCI). (2019e). Industry Wide Environmental Product Declaration - Vinyl Composition Tile. UL Environment. Retrieved from https://rfci.com/wp-content/uploads/2019/01/105.1_RFCI_EPD_Vinyl-Composition-Tile.pdf

Resilient Floor Covering Institute (RFCI). (2019f). Industry Wide Environmental Product Declaration - Vinyl Tile. UL Environment. Retrieved from https://rfci.com/wp-content/uploads/2019/01/106.1_RFCI_EPD_Vinyl-Tile.pdf

Spray Polyurethane Foam Alliance (SPFA). (2018a). Environmental Product Declaration - Spray Polyurethane Foam Insulation (HFC). ASTM International. Retrieved from https://www.astm.org/CERTIFICATION/DOCS/414.EPD_for_SPFA-EPD-20181029-HFC.pdf

Spray Polyurethane Foam Alliance (SPFA). (2018b). Environmental Product Declaration - Spray Polyurethane Foam Insulation (HFO). ASTM International. https://doi.org/10.4324/9781315270326-75

Steel Deck Institute (SDI). (2018). Environmental Product Declaration - Steel Deck. UL Environment. Retrieved from https://www.sdi.org/wp-content/uploads/2018/08/SDI-EPD-073018.pdf

Steel Joist Institute (SJI). (2015). Environmental Product Declaration - Open Web Steel Joists and Joist Girders. UL Environment. Retrieved from https://steeljoist.org/wp-content/uploads/SJI-EPD-2015-11-23.pdf

Steel Recycling Institute (SRI). (2016). Environmental Product Declaration - Industry-wide Cold-Formed Steel Studs and Track manufactured in U.S. and Canada. SCS Global Services. Retrieved from https://www.scscertified.com/products/cert_pdfs/SCS-EPD-03838_SRI_CFS-Stud-Track_011916_web.pdf?r=1

UL Environment. (2016). Product Category Rule (PCR) Guidance for Building-Related Products and Services Part B: Processed Glass EPD Requirements. https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=35842