Declaration Owner

Hufcor, Inc.
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Products

640 Series - Manual Operable Walls:

- 640 Panels Non Steel Face - Vinyl
- 640 Panels Non Steel Face - Carpet
- 640 Panels Non Steel Face - Fabric / Acoustical Harmony

Functional Unit

The functional unit is one square meter of movable wall system product maintained for 75 years.

EPD Number and Period of Validity

SCS-EPD-07019
EPD Valid May 18, 2021 through May 17, 2026

Product Category Rule

ISO 21930:2017. Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.

Program Operator

SCS Global Services
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Declaration Owner:	Hufcor, Inc.
Address:	2101 Kennedy Rd, Janesville, WI 53545
Declaration Number:	SCS-EPD-07019
Declaration Validity Period:	EPD Valid May 18, 2021 through May 17, 2026
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Gerard Mansell, PhD. SCS Global Services
LCA Software:	OpenLCA 1.10
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Tom Gloria, Ph.D., Industrial Ecology Consultants
Product Category Rule:	ISO 21930:2017. Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.
PCR Review conducted by:	ISO Technical Committee
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Tom Gloria, Ph.D., Industrial Ecology Consultants
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Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and 21930.*

Scope of Results Reported: *The PCR requirements limit the scope of the LCA metrics such that the results exclude environmental and social performance benchmarks and thresholds, and exclude impacts from the depletion of natural resources, land use ecological impacts, ocean impacts related to greenhouse gas emissions, risks from hazardous wastes and impacts linked to hazardous chemical emissions.*

Accuracy of Results: *Due to PCR constraints, this EPD provides estimations of potential impacts that are inherently limited in terms of accuracy.*

Comparability: *The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.*

In accordance with ISO 21930:2017, EPDs are comparable only if they comply with the core PCR, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

1. About Hufcor

Hufcor, the leader in flexible space management and operable partitions, is a global company based in Janesville, Wisconsin. At Hufcor, we exist to shape the experience that people have within a built environment – we are in the business of space management. Offering the widest range of glass, operable, vertical lift and accordion partitions, our products shape space by providing flexible sight and sound separation and enable our customers to control the atmosphere and experience of their space.

Shaping your experience is not just about what we do, but how we approach business. Committed to advancing what is possible in space management, we are consultants that have more, do more, and deliver more for our customers. Every day we work with architects, contractors, and building owners across markets to help them maximize the utilization of their space to realize what is possible. We shape our customer's experience through the breadth and quality of our expertise, capabilities, and products along with our inherent drive to solve problems. This uniquely positions Hufcor to reliably deliver exactly what is needed.

Hufcor is the most installed brand of operable partitions worldwide. We offer our customers a global solution through dedicated manufacturing facilities in the United States, Australia, New Zealand, Germany, China, and Malaysia. With its vast distribution network, the company's products have been installed in hotels, convention centers, schools, universities, and places of worship throughout the world.

- Hufcor was founded in 1900, and today is a privately held corporation headquartered in Janesville, Wisconsin USA in a 310,000 sq. ft. office and manufacturing facility.
- Hufcor encompasses the globe with a network greater than a hundred of experienced distributors and sales offices.
- Hufcor achieved ISO 9001 registration in 1996. ISO registration confirms that we have processes and systems in place that conform to international quality standards.
- Effective sound separation is a critical requirement of operable partitions. Hufcor built an acoustical testing laboratory in 1969 that is still used today to validate our operable partition sound ratings. Hufcor's sound laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) -- assurance that tests are conducted under strict procedures.

2. Product

An operable (movable) partition is a system of individual solid or glazed panels that can move independently from each other which when fitted together end to end form a continuous flat, faceted or curved wall. Operable wall panels are designed to be easily maneuvered and operated manually or automatic. They are top hung from either a surface or recessed mounted head track and no floor track is required. Various head track formations are possible to provide different stacking options.

Hufcor operable partitions are the most versatile and attractive movable wall constructed today. It combines the durability of a welded steel frame to achieve greater heights, straight lines, and superior sound control, with the design versatility of a wide range of acoustical and decorative face constructions.

The product lines and individual product included in the EPD are summarized below. Results are presented as an average for each product line.

Hufcor Series 600™ operable partitions—also known as Airwalls,® movable walls or flat panels—are recognized worldwide for their unparalleled quality, design flexibility, acoustic performance and lasting durability.

Product Line	Product Name	Description
600 Series - Manual Operable Walls: 640 Model - Non Steel Face	640 Panels Non Steel Face - Vinyl	Panels are nominally 4" [102] thick and have a frame of 16 gauge steel. The top horizontal sound seal is of multi-finger vinyl, and the bottom sound seal is retractable and provides up to 2" [50] floor clearance (to accommodate out-of-level floors). The face substrate varies by the level of sound control required, STC rating including Steel, Gypsum, Medium Density Fiberboard. The faces may be covered from a wide selection of vinyl, carpet and fabric colors and patterns, factory applied. Other finishes include wood veneer, high pressure laminate, painted steel, acrylic. 641 are acoustic individual, omni-directional panels, manually operated panels offering optimum room flexibility. The track system enables panels to negotiate turns and be used in alternate locations. 642 offer acoustic panels hinged in pairs allowing fast setup. They may be stacked at either or both ends of the track or in a "pocket".
	640 Panels Non Steel Face - Carpet	
	640 Panels Non Steel Face - Fabric	
	640 Panels Non Steel Face - Acoustical Harmony	

Hufcor's operable partition system products are manufactured at the company's production facility in Janesville, Wisconsin. The products are constructed from a variety of materials including steel, aluminum, glass, plastics, textiles and coatings sourced from various suppliers.

2.2 Application

The Hufcor operable partition system products are intended for interior applications including commercial office environments, education, healthcare, hospitality, convention facilities, and multi-purpose spaces providing the primary function of partitioning interior spaces.

2.3 Technical Data

Technical specifications of the products included in the LCA scope, as well as product performance testing results are available on the manufacturer's website (https://www.hufcor.com).

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2.4 Base Materials

The primary materials include steel, aluminum, glass, plastics, textiles and coatings sourced from various suppliers. Packaging materials consist of plastic and wood pallets.

Table 2. *Material content for the Hufcor operable partition system products in kg per square meter and percent of total mass.*

Material	640 Panels Non Steel Face - Vinyl		640 Panels Non Steel Face - Carpet		640 Panels Non Steel Face - Acoustical Harmony		640 Panels Non Steel Face - Fabric	
	kg/m²	Percent	kg/m²	Percent	kg/m²	Percent	kg/m²	Percent
Aluminum	0.215	6%	0.215	6%	0.215	7%	0.215	7%
Steel	1.03	30%	0.918	27%	0.918	28%	0.918	28%
Plastics	0.237	7%	0.237	7%	0.237	7%	0.237	6%
Vinyl	0.134	4%	0.00	0%	0.00	0%	0.00	0%
Gypsum	1.85	53%	1.85	55%	1.85	56%	1.85	55%
Fabric/Carpet	0.00	0%	0.149	4%	6.88×10^{-2}	2%	0.149	4%
Total Product	**3.47**	**100%**	**3.37**	**100%**	**3.29**	**100%**	**3.37**	**100%**

Table 3. *Material content for the Hufcor operable partition system product packaging, per functional unit.*

Material	640 Panels Non Steel Face - Vinyl		640 Panels Non Steel Face - Carpet		640 Panels Non Steel Face - Acoustical Harmony		640 Panels Non Steel Face - Fabric	
	kg/m²	Percent	kg/m²	Percent	kg/m²	Percent	kg/m²	Percent
Plastic	7.87×10^{-4}	2%	7.87×10^{-4}	2%	7.87×10^{-4}	2%	7.87×10^{-4}	2%
Wood	3.46×10^{-2}	98%	3.46×10^{-2}	98%	3.46×10^{-2}	98%	3.46×10^{-2}	98%
Total Packaging	**3.54×10^{-2}**	**100%**	**3.54×10^{-2}**	**100%**	**3.54×10^{-2}**	**100%**	**3.54×10^{-2}**	**100%**

2.5 Manufacture

Hufcor's operable partition system products are manufactured at the company's production facility in Janesville, Wisconsin. Resource use at the production facility is allocated to the product based on product mass as a fraction of facility production (mass-based allocation).

2.6 Environment and Health during Manufacture

No environmental or health impacts are expected during the manufacture of the product.

2.7 Product Processing/Installation

Typical installation is accomplished using hand tools.

2.8 Packaging

The Hufcor products are packaged for shipment using corrugated board, plastic and wood pallets.

2.9 Condition of Use

No special conditions of use are noted.

2.10 Environment and Health during use

No environmental or health impacts are expected due to normal use of the wall system.

2.11 Reference Service Life

The Reference Service Life (RSL) of the wall system product is based on the manufacturer's estimated product lifetime of 25 years, as summarized in Table 3 below. The building Estimated Service Life (ESL) is 75 years, consistent with the PCR.

2.12 Extraordinary Effects

No environmental or health impacts are expected due to extraordinary effects including fire and/or water damage and unforeseeable mechanical destruction.

2.13 Further Information

Further information on the product can be found on the manufacturers' website at https://www.hufcor.com.

3. LCA: Calculation Rules

3.1 Functional Unit

The functional unit used in the study is defined as 1 m^2 of operable wall system product maintained for 75 year. The reference flows for each product are summarized in Table 3.

Table 3. *Reference flows for the Hufcor operable wall system products, per square meter.*

Product Name	Functional Unit	Reference flow (kg/m^2)	Reference Service Life (RSL) (years)	Replacement Cycle (ESL/RSL-1)
640 Panels Non Steel Face - Vinyl	1 m^2 wall surface	3.47	25	2.0
640 Panels Non Steel Face - Carpet	1 m^2 wall surface	3.37	25	2.0
640 Panels Non Steel Face - Acoustical Harmony	1 m^2 wall surface	3.29	25	2.0
640 Panels Non Steel Face - Fabric	1 m^2 wall surface	3.37	25	2.0

3.2 System Boundary

The scope of the EPD is cradle-to-grave, including raw material extraction and processing, transportation, product manufacture, product delivery, installation and use, and product disposal. The life cycle phases included in the EPD scope are described in Table 4 and illustrated in Figure 1.

Table 4. *The modules and unit processes included in the scope for the Hufcor products.*

Module	Module description from the PCR	Unit Processes Included in Scope
A1	Extraction and processing of raw materials; any reuse of products or materials from previous product systems; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Extraction and processing of raw materials for the operable partition system components.
A2	Transport (to the manufacturer)	Transport of component materials to the manufacturing facilities
A3	Manufacturing, including ancillary material production	Manufacturing of products and packaging (incl. upstream unit processes*)
A4	Transport (to the building site)	Transport of product (including packaging) to the building site
A5	Construction-installation process	Impacts from the installation of product are assumed negligible. Only impacts from packaging disposal are included in this phase
B1	Product use	There are no impacts associated with the use of the products.
B2	Product maintenance	Maintenance of products over the 75-year ESL, including periodic cleaning. Impacts from product maintenance are assumed negligible
B3	Product repair	The products are not expected to require repair over its lifetime
B4	Product replacement	The materials and energy required for replacement of the product over the 75-year ESL of the assessment are included in this phase
B5	Product refurbishment	The products are not expected to require refurbishment over their lifetime
B6	Operational energy use by technical building systems	Operational energy consumption of the wall system in a commercial building setting. Impacts from electricity consumption associated with the use of the products are included in this phase.
B7	Operational water uses by technical building systems	There is no operational water use associated with the use of the product
C1	Deconstruction, demolition	Demolition of the product is accomplished using hand tools with no associated emissions and negligible impacts
C2	Transport (to waste processing)	Transport of the product to waste treatment at end-of-life
C3	Waste processing for reuse, recovery and/or recycling	The products are disposed of by landfilling or incineration which require no waste processing
C4	Disposal	Disposal of the product in a municipal landfill or incineration
D	Reuse-recovery-recycling potential	Module Not Declared

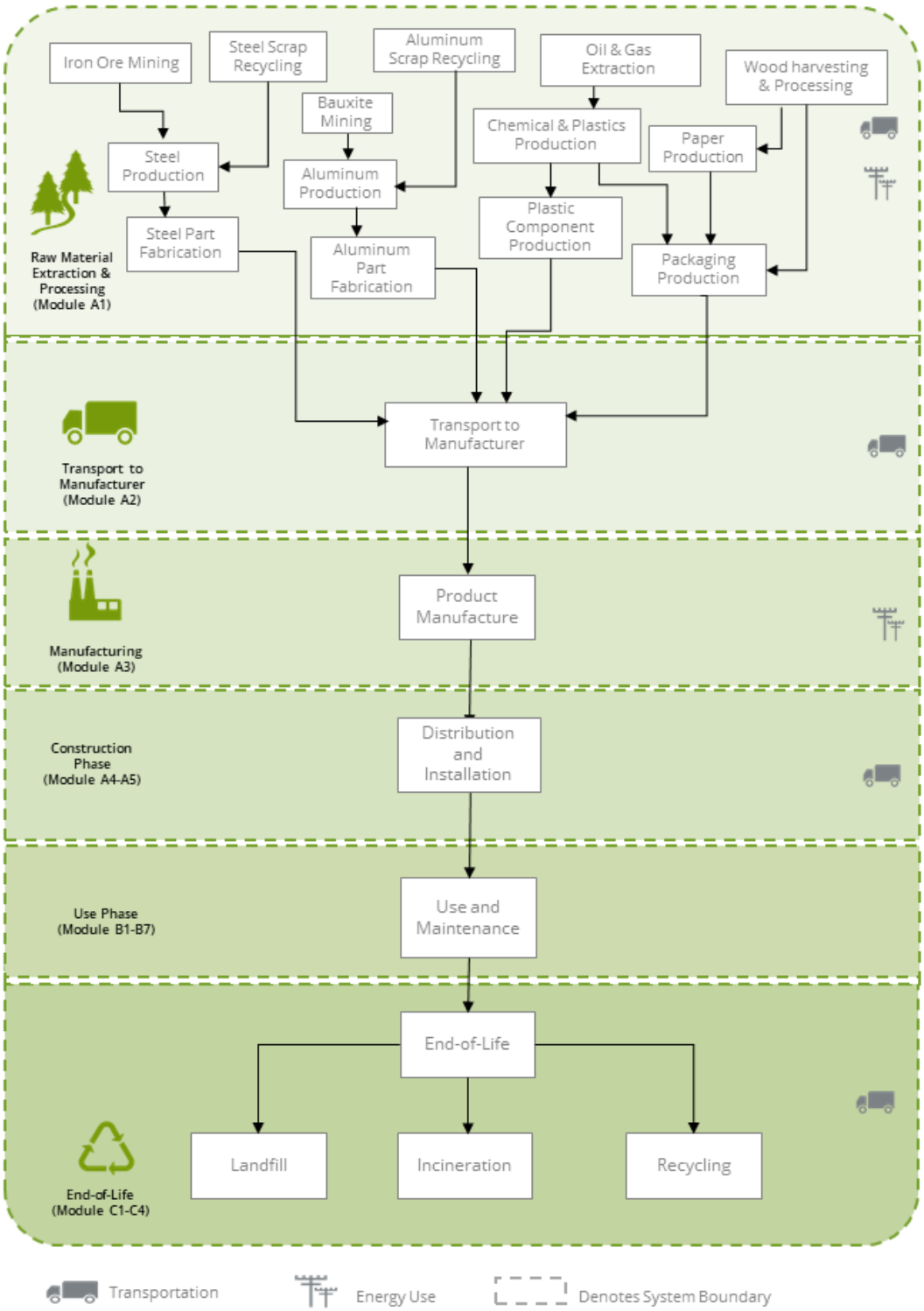

Figure 1. *Flow diagram representing the major unit operations in the life cycle of the Hufcor operable wall system products.*

3.3 Estimates and Assumptions

- The Janesville, Wisconsin facility is located in the MROE eGRID EPA NERC sub-region. An Ecoinvent inventory dataset was modified to reflect the eGRID energy mix for MROE to estimate resource use and emissions from electricity use at the Janesville, Wisconsin facility.
- Electricity and resource use at the production facility were allocated to the operable partition system products based on product mass utilizing production data for calendar year 2019 provided by the manufacturer.
- Primary data for upstream component fabrication were not available. Representative LCI datasets from the ecoinvent database were used to model processing for aluminum, steel and plastic material components.
- The specific recycled content of the steel components was unknown and assumed to be manufactured using the Basic Oxygen Furnace (BOF) steel-making route which typically contents less than ~20% recycled content.
- For end-of-life, disposal of the product and product packaging is modeled based on 2018 statistics for municipal solid waste generation and disposal in the United States, from the US Environmental Protection Agency. These data provide recycling rate estimates for household and municipal waste, durable and non-durable goods, as well as for packaging and containers.
- For final disposal of the product and packaging materials at end-of-life, all materials are assumed to be transported 20 miles by diesel truck to either a landfill, incineration facility, or material reclamation facility (for recycling). Datasets representing disposal in a landfill and waste incineration are from Ecoinvent.
- Modeling of recycled materials follows the recycled content method (also known as 100-0 method or cut-off method) whereby only the burdens of reprocessing the waste material are allocated to the system from the use of the recycled material.

It should also be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

The PCR allows for the results for several inventory flows related to construction products to be reported as “other parameters”. These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted taking into account this limitation.

3.4 Cut-off criteria

According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact are included in the inventory. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results. No known flows are deliberately excluded from this EPD.

3.5 Background Data

Primary data were provided by Hufcor for the Janesville, Wisconsin manufacturing facility. The sources of secondary LCI data are the Ecoinvent database.

Table 4. *Data sources for the Hufcor operable partition system products.*

Component	Dataset	Data Source	Publication Date
PRODUCT			
Aluminum			
Aluminum - virgin	aluminium production, primary, ingot | aluminium, primary, ingot | Cutoff, S/RNA	EI v3.7	2020
Recycled Al - post-consumer	market for aluminium scrap, post-consumer | aluminium scrap, post-consumer | Cutoff, S/GLO	EI v3.7	2020
Recycled Al - post-industrial	market for aluminium scrap, new | aluminium scrap, new | Cutoff, S/RoW	EI v3.7	2020
Steel			
BOF Steel	steel production, converter, low-alloyed | steel, low-alloyed | Cutoff, S/RoW	EI v3.7	2020
EAF Steel	steel production, electric, low-alloyed | steel, low-alloyed | Cutoff, S/RoW	EI v3.7	2020
Plastics			
Polyester	polyethylene terephthalate production, granulate, bottle grade | polyethylene terephthalate, granulate, bottle grade | Cutoff, S/RoW	EI v3.7	2020
Polyurethane	polyurethane production, flexible foam | polyurethane, flexible foam | Cutoff, S/RoW	EI v3.7	2020
Textiles			
Carpet	polyethylene terephthalate, granulate, amorphous, recycled to generic market for amorphous PET granulate | polyethylene terephthalate, granulate, amorphous | Cutoff, S/US; Electricity, medium voltage, per kWh - U.S./U.S.	EI v3.7	2020
Fabrics	polyethylene terephthalate production, granulate, amorphous | polyethylene terephthalate, granulate, amorphous | Cutoff, S/RoW; Electricity, medium voltage, per kWh - U.S./U.S.	EI v3.7	2020
Vinyl			
PVC	polyvinylchloride production, bulk polymerisation | polyvinylchloride, bulk polymerised | Cutoff, S/RoW	EI v3.7	2020
Gypsum			
Gypsum	market for gypsum, mineral | gypsum, mineral | Cutoff, S/RoW	EI v3.7	2020
PACKAGING			
Wrapping Film	market for packaging film, low density polyethylene | packaging film, low density polyethylene | Cutoff, S/GLO	EI v3.7	2020
Wood Crates	market for EUR-flat pallet | EUR-flat pallet | Cutoff, S/GLO	EI v3.7	2020
TRANSPORT			
Road transport	market for transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, S/RoW	EI v3.7	2020
Ship transport	transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, S/GLO	EI v3.7	2020
RESOURCES			
Grid electricity	Electricity, medium voltage, per kWh - MROE/MROE	EI v3.7	2020
Heat – natural gas	market group for heat, district or industrial, natural gas | heat, district or industrial, natural gas | Cutoff, S/GLO	EI v3.7	2020
Heat – diesel	market for diesel, burned in building machine | diesel, burned in building machine | Cutoff, S/GLO	EI v3.7	2020

3.6 Data Quality

The data quality assessment addressed the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 5. *Data quality assessment for the Hufcor product system.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these data are less than 5 years old (typically 2016). All of the data used represented an average of at least one year's worth of data collection, and up to three years in some cases. Manufacturer-supplied data (primary data) are based on annual production for 2019.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Electricity use for product manufacture is modeled using representative data for the US. Surrogate data used in the assessment are representative of global or European operations. Data representative of European operations are considered sufficiently similar to actual processes. Data representing product disposal are based on regional statistics.
Technology Coverage: Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations. Representative fabrication datasets, specific to the type of material, are used to represent the actual processes, as appropriate.
Precision: Measure of the variability of the data values for each data expressed	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Completeness: Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of the wall system products. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used; with a bias towards Ecoinvent v3.7 data where available. Different portions of the product life cycle are equally considered.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Sources of the Data: Description of all primary and secondary data sources	Energy use data at Hufcor's manufacturing facility represents an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. For secondary LCI data, Ecoinvent v3.7 LCI data are used.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the products and packaging is low. Actual supplier data for upstream operations were not available and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

3.7 Period under review

The period of review is calendar year 2019.

3.8 Allocation

Manufacturing resource use was allocated to the products based on product mass as a fraction of annual facility production (mass-based allocation). Impacts from transportation were allocated based on the mass of material and distance transported.

The product system includes some recycled materials, which were allocated using the recycled content allocation method (also known as the 100-0 cut-off method). Using the recycled content allocation approach, system inputs with recycled content do not receive any burden from the previous life cycle other than reprocessing of the waste material. At end-of-life, materials which are recycled leave the system boundaries with no additional burden.

3.9 Comparability

The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.

4. LCA: Scenarios and Additional Technical Information

Delivery and Installation stage (A4 - A5)

Distribution of the wall system products to the point of installation is included in the assessment. Transportation parameters for modeling product distribution are summarized in Table 6. The manufacturer estimates an average distance of ~1,200 kilometers for distribution in North America.

Table 6. *Product distribution parameters, per functional unit.*

Transport Parameter	640 Panels Non Steel Face - Vinyl	640 Panels Non Steel Face - Carpet	640 Panels Non Steel Face - Acoustical Harmony	640 Panels Non Steel Face - Fabric
Diesel truck – Fuel utilization (L/100 km)	18.7	18.7	18.7	18.7
Diesel truck – Capacity utilization (%)	76%	76%	76%	76%
Diesel truck – Distance (km)	1,200	1,200	1,200	1,200
Gross mass of products transported (including packaging)[1] (kg)	3.51	3.41	3.33	3.41

The impacts associated with the product installation are assumed negligible. The impacts associated with packaging disposal are included with the installation phase as per PCR requirements.

Table 7. *Installation parameters for the Hufcor products, per functional unit.*

Parameter		640 Panels Non Steel Face - Vinyl	640 Panels Non Steel Face - Carpet	640 Panels Non Steel Face - Acoustical Harmony	640 Panels Non Steel Face - Fabric
Ancillary materials – Glass (kg)		-	-	-	-
Net freshwater consumption (m^3)		-	-	-	-
Electricity consumption (kWh)		-	-	-	-
Product loss per functional unit (kg)		negligible	negligible	negligible	negligible
Waste materials generated by product installation (kg)		negligible	negligible	negligible	negligible
Output materials resulting from on-site waste processing (kg)		na	na	na	na
Mass of packaging waste (kg)	Plastic	7.87×10^{-4}	7.87×10^{-4}		7.87×10^{-4}
	Wood	3.46×10^{-2}	3.46×10^{-2}		3.46×10^{-2}
Biogenic carbon contained in packaging (kg CO_2)		6.35×10^{-2}	6.35×10^{-2}	6.35×10^{-2}	6.35×10^{-2}
Direct emissions (kg)		-	-	-	-

Use and Maintenance stage (B1 - B2)

No impacts are associated with the use of the products. Impacts from routine cleaning and maintenance of the products are assumed negligible.

Repair stage (B3)

Repair of the product is not relevant during the lifetime of the product; results for this stage are reported as zero.

Replacement stage (B4)

The materials and energy required for replacement and maintenance of the product over the 75-year ESL of the assessment are included in this stage.

Refurbishment stage (B5)

Product refurbishment is not relevant during the lifetime of the product.

Building operation stage (B6 – B7)

There is no operational energy or water use associated with the use of the product.

Disposal stage (C1 - C4)

The disposal stage includes removal of the products (C1); transport of the products to waste treatment facilities (C2); waste processing (C3); and associated emissions as the product degrades in a landfill or is burned in an incinerator (C4). For the architectural wall system products, no emissions are generated during demolition (C1) while no waste processing (C3) is required for incineration or landfill disposal.

Transportation of waste materials at end-of-life (C2) assumes a 20 mile (~32 km) average distance to disposal, consistent with assumptions used in the US EPA WARM model. The recycling rates used for the product and packaging are based on regional statistics regarding municipal solid waste generation and disposal in the United States for 2018, from the US Environmental Protection Agency. The relevant disposal statistics used for the packaging are summarized in Table 8 and Table 9. For material not recycled, 80% are assumed landfilled and 20% incinerated.

Table 8. *Recycling rates for product and packaging materials at end-of-life.*

Material	Product Recycling rate (%)	Packaging Recycling rate (%)
Recycling Rates		
Non-ferro Metals	67.6%	n/a
Plastic	6.6%	14.6%
Steel	27.8%	n/a
Textile	13.7%	n/a
Wood	-	26.1%
Wood	-	26.1%
Disposal of Non-recyclables		
Landfill	80.0%	80.0%
Incineration	20.0%	20.0%

Table 9. *End-of-life disposal scenario parameters for the Hufcor operable partition system products.*

Parameter		640 Panels Non Steel Face - Vinyl	640 Panels Non Steel Face - Carpet	640 Panels Non Steel Face - Acoustical Harmony	640 Panels Non Steel Face - Fabric
Assumptions for scenario development		EPA 2018 MSW	EPA 2018 MSW	EPA 2018 MSW	EPA 2018 MSW
Collection process		-			
Collected with mixed construction waste (kg)		3.47	3.49	3.41	3.49
Recovery		n/a	n/a	n/a	n/a
Disposal	Recycled (kg)	0.457	0.468	0.457	0.458
	Landfill (kg)	2.41	2.41	2.36	2.41
	Incineration (kg)	0.603	0.604	0.50	0.604
Removals of biogenic carbon (kg CO_2 eq)[1]		n/a	n/a	n/a	n/a

[1] *Excludes Packaging*

5. LCA: Results

Results of the Life Cycle Assessment are presented below. It is noted that LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Table 10. *Life cycle phases included in the product system boundary.*

Product			Construction Process		Use							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MND

X = Included in system boundary | MND = Module not declared

The following impact indicators, specified by the PCR, are reported below:

TRACI 2.1 Impact Category	Unit
Global Warming Potential (GWP)	kg CO_2 eq
Ozone Depletion Potential (ODP)	kg CFC 11 eq
Acidification Potential (AP)	kg SO_2 eq
Eutrophication Potential (EP)	kg N eq
Smog Formation Potential (SFP)	kg O_3 eq
Fossil Fuel Depletion Potential (ADP_{fossil})	MJ Surplus, LHV

These impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development, however the EPD users shall not use additional measures for comparative purposes.

The following inventory parameters, specified by the PCR, are also reported.

Resources	Unit	Waste and Outflows	Unit
RPR_E: Renewable primary resources used as energy carrier (fuel)	MJ, LHV	HWD: Hazardous waste disposed	kg
RPR_M: Renewable primary resources with energy content used as material	MJ, LHV	NHWD: Non-hazardous waste disposed	kg
$NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel)	MJ, LHV	HLRW: High-level radioactive waste, conditioned, to final repository	kg
$NRPR_M$: Non-renewable primary resources with energy content used as material	MJ, LHV	ILLRW: Intermediate- and low-level radioactive waste, conditioned, to final repository	kg
SM: Secondary materials	MJ, LHV	CRU: Components for re-use	kg
RSF: Renewable secondary fuels	MJ, LHV	MR: Materials for recycling	kg
NRSF: Non-renewable secondary fuels	MJ, LHV	MER: Materials for energy recovery	kg
RE: Recovered energy	MJ, LHV	EE: Recovered energy exported from the product system	MJ, LHV
FW: Use of net freshwater resources	m^3		

Modules B1, B2, B3, B5 and B7 are not associated with any impact and are therefore declared as zero. In addition, module C1 and C3 are likewise not associated with any impact as the products are expected to be manually deconstructed. Additionally, as the products do not contain significant amounts of bio-based materials, biogenic carbon emissions and removals are not declared. Module D is not declared. In the interest of space and table readability, these modules are not included in the results presented below.

Table 10. *Life Cycle Impact Assessment (LCIA) results for the **640 Panels Non Steel Face** products over a 75-yr time horizon. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.*

Impact Category	A1	A2	A3	A4	A5	B4	C2	C4
TRACI								
GWP (kg CO_2 eq)	9.11	0.186	1.07	1.16	$3.73x10^{-3}$	25.6	0.141	1.14
	24%	0.49%	2.8%	3.0%	0.01%	67%	0.37%	3.0%
ODP (kg CFC-11 eq)	$1.55x10^{-6}$	$4.34x10^{-8}$	$5.31x10^{-8}$	$2.70x10^{-7}$	$4.40x10^{-10}$	$3.92x10^{-6}$	$3.26x10^{-8}$	$1.10x10^{-8}$
	26%	0.74%	0.90%	4.6%	0.01%	67%	0.55%	0.19%
AP (kg SO_2 eq)	$4.45x10^{-2}$	$8.45x10^{-4}$	$4.39x10^{-3}$	$5.27x10^{-3}$	$1.17x10^{-5}$	0.113	$8.11x10^{-4}$	$5.73x10^{-4}$
	26%	0.50%	2.6%	3.1%	0.01%	67%	0.48%	0.34%
EP (kg N eq)	$3.38x10^{-2}$	$2.07x10^{-4}$	$5.81x10^{-3}$	$1.29x10^{-3}$	$2.12x10^{-4}$	0.115	$1.04x10^{-4}$	$1.61x10^{-2}$
	20%	0.12%	3.4%	0.75%	0.12%	67%	0.06%	9.3%
SFP (kg O_3 eq)	0.515	$2.05x10^{-2}$	$5.07x10^{-2}$	0.127	$3.26x10^{-4}$	1.50	$2.30x10^{-2}$	$1.25x10^{-2}$
	23%	0.91%	2.3%	5.7%	0.01%	67%	1.0%	0.55%
FFD (MJ eq)	9.17	0.394	1.09	2.46	$4.06x10^{-3}$	27.0	0.290	0.113
	23%	0.97%	2.7%	6.1%	0.01%	67%	0.72%	0.28%
Resources								
RPR_E (MJ)	16.2	$3.11x10^{-2}$	1.63	0.194	$2.19x10^{-4}$	36.2	$7.22x10^{-3}$	$3.37x10^{-2}$
	30%	0.06%	3.0%	0.36%	0.00%	67%	0.01%	0.06%
RPR_M (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$NRPR_E$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
$NRPR_M$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA
SM (kg)	$2.76x10^{-2}$	0.00	0.00	0.00	0.00	$5.51x10^{-2}$	0.00	0.00
	33%	0.00%	0.00%	0.00%	0.00%	67%	0.00%	0.00%
RSF/NRSF (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
RE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
FW (m^3)	0.378	$1.96x10^{-3}$	$4.72x10^{-2}$	$1.22x10^{-2}$	$1.86x10^{-5}$	0.887	$6.19x10^{-4}$	$3.70x10^{-3}$
	28%	0.15%	3.5%	0.92%	0.00%	67%	0.05%	0.28%
Wastes								
HWD (kg)	$3.16x10^{-4}$	$7.34x10^{-6}$	$9.54x10^{-6}$	$4.58x10^{-5}$	$6.66x10^{-8}$	$7.73x10^{-4}$	$5.23x10^{-6}$	$2.55x10^{-6}$
	27%	0.63%	0.82%	3.9%	0.01%	67%	0.45%	0.22%
NHWD (kg)	2.28	0.132	0.523	0.826	$2.85x10^{-2}$	12.5	$9.15x10^{-3}$	2.43
	12%	0.71%	2.8%	4.4%	0.15%	67%	0.05%	13%
HLRW (kg)	$2.38x10^{-5}$	$1.46x10^{-7}$	$1.99x10^{-7}$	$9.12x10^{-7}$	$1.06x10^{-9}$	$5.05x10^{-5}$	$3.20x10^{-8}$	$1.72x10^{-7}$
	31%	0.19%	0.26%	1.2%	0.00%	67%	0.04%	0.23%
ILLRW (kg)	$1.86x10^{-4}$	$1.83x10^{-5}$	$5.01x10^{-6}$	$1.14x10^{-4}$	$1.84x10^{-7}$	$6.83x10^{-4}$	$1.37x10^{-5}$	$4.23x10^{-6}$
	18%	1.8%	0.49%	11%	0.02%	67%	1.3%	0.41%
CRU (kg)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MR (kg)	0.00	0.00	0.00	0.00	$1.18x10^{-4}$	0.922	0.00	0.461
	0.00%	0.00%	0.00%	0.00%	0.01%	67%	0.00%	33%
MER (kg)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
EE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

6. LCA: Interpretation

The interpretation phase conforms to ISO 14044 with further guidance from the ILCD General Guide for Life Cycle Assessment. The interpretation included the use of evaluation and sensitivity checks to steer the iterative process during the assessment, and a final evaluation including completeness, sensitivity, and consistency checks, at the end of the study.

Cradle-to-grave impact results are summarized by life cycle phase for the functional unit of each product maintained for 75 years. The product replacement phase (*B4*) accounts for approximately 67% of the total impacts over the 75-yr ESL of the assessment. Excluding the product replacements, the contributions to the indicator results are dominated by the raw material and extraction phase (*A1*), due to the extraction and fabrication of metal components of the product. Approximately 20-50% of the Raw Material Extraction phase impacts are due to the fabrication of the metal components, depending on the specific product. The product distribution and installation phases (A4/A5) are generally the next highest contributors to overall impacts followed by product manufacturing (A3).

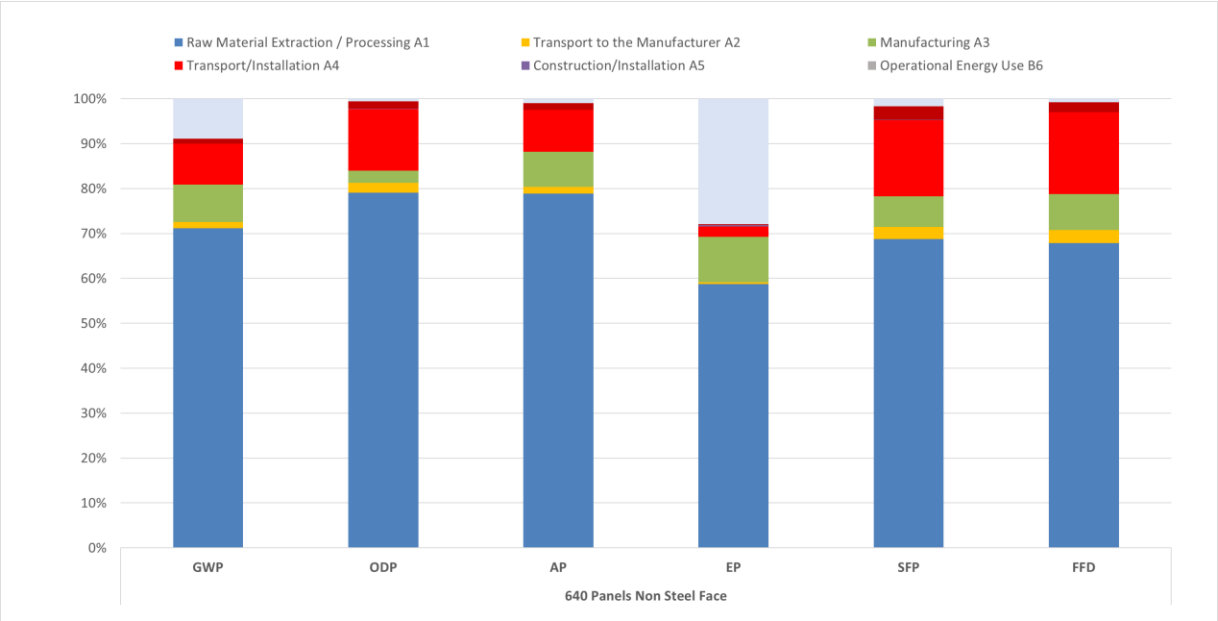

Figure 2. *Contribution analysis for the Hufcor operable partition system products (excluding product replacements) – TRACI 2.1.*

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