Declaration Owner

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Product

Merge Forward Polypropylene Composite Tile flooring

(UNSPSC Class Code 30161700/CSI Code 09 65 00)

Functional Unit

The functional unit is one square meter of flooring over a 75-year period.

EPD Number and Period of Validity

SCS-EPD-09447
EPD Valid October 4, 2023 through October 3, 2028

Product Category Rule

PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. December 2018.

PCR Guidance for Building-Related Products and Services Part B: Flooring EPD Requirements. Version 2. UL Environment. September May 2018.

Program Operator

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Declaration Owner:	Milliken
Address:	920 Milliken Road. Spartanburg, SC 29303, USA
Declaration Number:	SCS-EPD-09447
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LCA Practitioner:	Gerard Mansell, Ph.D., SCS Global Services
LCA Software and LCI database:	OpenLCA v1.11 software and the Ecoinvent v3.9 database
Product RSL:	10 years
Markets of Applicability:	North America
EPD Type:	Product-Specific
EPD Scope:	Cradle-to-Grave
LCIA Method and Version:	CML-IA and TRACI 2.1
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants
Part A Product Category Rule:	PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 3.2. UL Environment. December 2022
Part A PCR Review conducted by:	Lindita Bushi, PhD (Chair); Hugues Imbeault-Tétreault, ing., M.Sc.A.; Jack Geibig
Part B Product Category Rule:	PCR Guidance for Building-Related Products and Services Part B: Flooring EPD Requirements. Version 2. UL Environment. September 2018.
Part B PCR Review conducted by:	Jack Geibig (chair), Ecoform; Thomas Gloria, Industrial Ecology Consultants; Thaddeus Owen
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Thomas 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. Milliken

Milliken is a leading supplier of floor coverings, with a rich history or delivering dynamic carpet and luxury vinyl tile collections from its award winning design studios and manufacturing facilities around the globe. Combining global insight with national expertise and proprietary technologies, Milliken is at the forefront of innovation and design, offering high-performance, expertly-engineered products. Founded in 1865, Milliken has achieved an amazing 150 years in the textiles business and is now one of the largest privately owned companies in the world, providing expert solutions across a range of disciplines, including specialty chemicals, floor coverings, and performance materials. With over 100 years of environmental stewardship, the Milliken family of companies is one of the world's more responsible manufacturers.

Designing innovative products and solutions for our customers is of the utmost importance. Through meaningful design, deep science and unique insights, we advance product development to the next level, while supporting Milliken's efforts to increase sustainable results and minimize environmental impact of all products. Milliken's holistic approach to innovation encompasses all stages of the life cycle - from material sourcing and manufacturing practices to end-of-life management. Our commitment to transparency, health, safety, quality and sustainability allows us to put our customers, associates, and communities first. In 2020, Milliken was named one of the World's Most Ethical Companies by the Ethisphere Institute for the fourteenth year running.

2. Product

2.1 PRODUCT DESCRIPTION

Merge Forward is the polypropylene composite tile which is PVC free. This product is made from recyclable material and consists of six layers. Heavy metals are not added during manufacturing, and has the characteristic of being 100% reusable and recyclable for rejected products that are produced during manufacturing.

Polypropylene (PP) which is the main raw material, is the lightest among synthetic resins and has excellent strength. In addition, a special polyethylene pad with excellent shock absorption and quietness is used for the bottom layer. The pad also has excellent workability, such as being able to be easily cut with a cutter during construction.

2.2 PRODUCT FLOW DIAGRAM

A flow diagram illustrating the production processes and life cycle phases included in the scope of the EPD is provided below.

2.3 APPLICATION

The products provide the primary function of flooring for interior applications. The flooring products are used in various residential and commercial applications including retail, healthcare, education, and hospitality.

2.4 DECLARATION OF METHODOLOGICAL FRAMEWORK

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 product system boundary are shown below.

Cut-off and allocation procedures are described below and conform to the PCR and ISO standards.

Table 1. *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 | MND = Module Not Declared

2.5 TECHNICAL DATA

Technical specifications for the composite tile flooring product are summarized in Table 2.

Table 2. *Product specifications for Merge Forward Polypropylene Composite Tile flooring.*

Characteristic			Description			
Sustainable certifications			ISO 9001			
VOC emissions test method						
Characteristic			**Nominal Value**	**Unit**	**Minimum Value**	**Maximum Value**
Product thickness			4.50 (0.18)	mm (inch)	4.30 (0.17)	4.70 (0.19)
Wear layer thickness			0.50 (0.02)	mm (inch)	0.50 (0.02)	0.50 (0.02)
Product weight			5,492.00 (18.00)	g/m^2 (oz/ft^2)	5,492.00 (18.00)	5,492.00 (18.00)
Product Form	Planks	Width	177.80 (7.00)	mm (inch)	177.60 (6.99)	178.00 (7.01)
		Length	1,219.20 (48.00)	mm (inch)	1,217.60 (47.94)	1,220.80 (48.06)
	Planks	Width	457.20 (18.00)	mm (inch)	456.90 (17.99)	457.50 (18.01)
		Length	914.40 (36.00)	mm (inch)	913.20 (35.95)	1915.60 (75.42)

2.6 MARKET PLACEMENT/APPLICATION RULES

Technical specifications of the flooring products are summarized above. Detailed product performance results can be found on the manufacturer's website https://floors.milliken.com.

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2.7 PROPERTIES OF DECLARED PRODUCT AS DELIVERED

The flooring products are delivered for installation in the form of planks of various dimensions.

2.8 MATERIAL COMPOSITION

The primary materials in the Merge Forward Polypropylene Composite Tile flooring include polypropylene, polyethylene, fillers and stabilizers.

Table 3. *Material content for the Polypropylene Composite Tile flooring products in kg per square meter and percent of total mass.*

Material	kg/m²	Percent mass
Polypropylene (36% recycled content)	2.98	54%
Polyethylene	8.70×10^{-2}	1.6%
$CaCO_3$	2.14	39%
Stabilizer	7.69×10^{-2}	1.4%
Other	0.209	3.8%
Total Product	**5.49**	**100%**

No substances required to be reported as hazardous are associated with the production of this product.

2.9 MANUFACTURING

The Merge Forward Polypropylene Composite Tile flooring products (UNSPSC Class Code 30161700/CSI Code 09 65 00) are manufactured at the production facility in Japan. The manufacturer provided primary data for their annual production, resource use and electricity consumption and waste generation at the facility. Electricity consumption is modeled using Ecoinvent datasets for the regional electricity grid resource mix in Japan.

The production of the flooring involves the following general manufacturing processes. Raw materials are fed into the bunbury mixer for mixing. Next, it is cut to a width that can be fed into the extruder and extruded. The required thickness is made by rolling and laminating together with printed sheet and balance sheet. The laminated sheets are then roughly cut. The cut sheet is then cooled and made into boards. Next, UV paint is applied, cured, and cut to the required width. Both ends of the

board are cut into the specified shape, and the required number of sheets are packed. Inspection is performed during the process and as a final inspection after the process is completed.

2.10 PACKAGING

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

Table 4. *Material content for the Polypropylene Composite Tile flooring product packaging in kg per square meter of flooring.*

Material	kg/m^2	Percent mass
Corrugated	8.00×10^{-2}	34%
Plastic	2.04×10^{-3}	0.88%
Wood	0.150	65%
Total Packaging	**0.232**	**100%**

2.11 PRODUCT INSTALLATION

Installation of the product is accomplished using hand tools with negligible impacts. The impacts associated with packaging disposal are included with the installation phase as per PCR requirements.

2.12 USE CONDITIONS

No special conditions of use are noted.

2.13 REFERENCE SERVICE LIFE

The Reference Service Life (RSL) of the flooring products varies based on the manufacturer's warranted lifetime.

2.14 RE-USE PHASE

The flooring products are not reused at end-of-life.

2.15 DISPOSAL

At end-of-life, the products are disposed of in a landfill.

2.16 FURTHER INFORMATION

Further information on the product can be found on the manufacturer's website https://floors.milliken.com.

3. LCA: Calculation Rules

3.1 FUNCTIONAL UNIT

The functional unit used in the study is defined as 1 m^2 of floor covering installed for use over a 75-year period. The corresponding reference flow for the product system is presented in Table 5. For the present assessment, a reference service lifetime (RSL) corresponding to the manufacturer's warranted lifetime is assumed. The total number of required product life cycles during the 75-year period over which the product system is modeled is also summarized in Table 5.

Table 5. *Reference flow and RSL for the flooring products.*

Product	Product Thickness (mm)	Reference flow (kg/m^2)	Mass conversion factor	Reference Service Life – RSL (years)	# of Product replacements (Replacement cycle)
Merge Forward Polypropylene Composite Tile	4.50	5.49	5.49	10	6.5

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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 6 and illustrated in Figure 1.

Table 6. *The modules and unit processes included in the scope for the flooring product system.*

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 flooring components.
A2	Transport (to the manufacturer)	Transport of component materials to the manufacturing facility
A3	Manufacturing, including ancillary material production	Manufacturing of flooring products and packaging (including upstream unit processes)
A4	Transport (to the building site)	Transport of product (including packaging) to the building site
A5	Construction-installation process	The product is installed using the manufacturer's recommended, or similar, adhesives with negligible impacts. Only impacts from packaging disposal are included in this phase.
B1	Product use	Use of the flooring in a commercial building setting. There are no associated emissions or impacts from the use of the product
B2	Product maintenance	Maintenance of products over the 75-year ESL, including periodic cleaning.
B3	Product repair	The flooring is 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 flooring is not expected to require refurbishment over its lifetime.
B6	Operational energy use by technical building systems	There is no operational energy use associated with the use of the product
B7	Operational water use 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 flooring product to waste treatment at end-of-life
C3	Waste processing for reuse, recovery and/or recycling	The product is disposed of by landfilling which require no waste processing
C4	Disposal	Disposal of flooring product in municipal landfill
D	Reuse-recovery-recycling potential	Module Not Declared

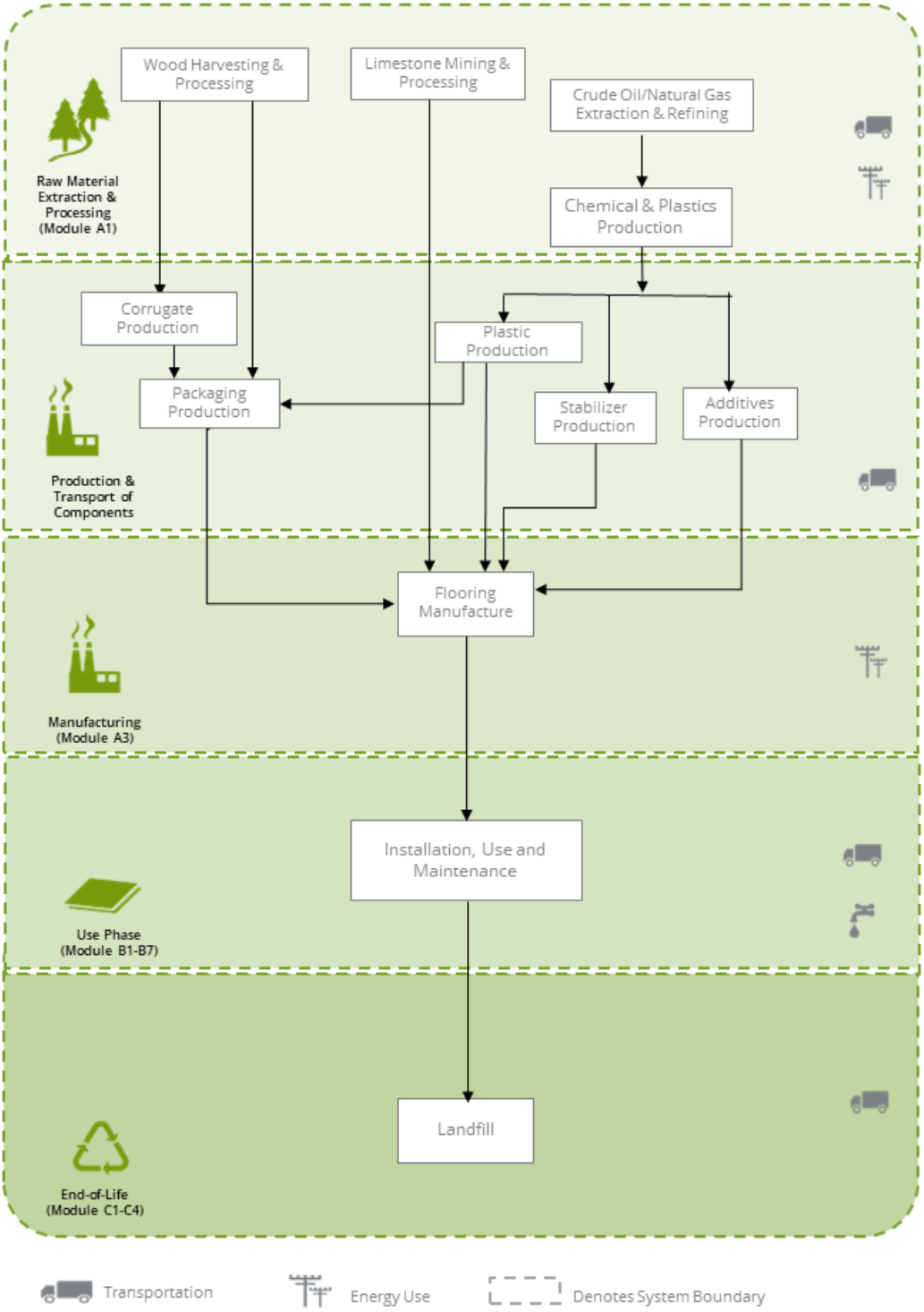

Figure 1. *Flow diagram for the life cycle of the Merge Forward Polypropylene Composite Tile flooring products.*

3.3 PRODUCT SPECIFIC CALCULATION FOR USE PHASE

The recommended cleaning regime is highly dependent on the use of the premises where the floor covering is installed. In high traffic areas more frequent cleaning will be needed compared to areas where there is low traffic. For the purposes of this EPD, average maintenance (moderate traffic levels) is presented based on typical installations.

3.4 UNITS

All data and results are presented using SI units.

3.5 ESTIMATES AND ASSUMPTIONS

- Electricity use at the manufacturing facility was allocated to the products based on the product area as a fraction of the total production.
- The manufacturing facility under review is located in Japan. Ecoinvent inventory datasets for the appropriate regional energy grid was used to model resource use and emissions from electricity use at the manufacturing facility.
- Inventory data for some material components were unavailable and modeled using proxy datasets from the Ecoinvent LCI databases.
- The Reference Service Life (RSL) of the products was modeled based on information provided by the manufacturers assuming their products are installed and maintained as recommended and used for the specific application noted.
- Downstream transport was modeled based on information provided by the manufacturers representing product distribution to North America.
- The maintenance phase of the product life cycle was modeled based on information provided by the manufacturers including recommended installation and cleaning methods, as well as cleaning frequency.
- For the product end-of-life, disposal of product and product packaging is modeled based on the PCR guidance regarding recycling rates of product and packaging materials.
- For final disposal of the packaging material and flooring products at end-of-life, all materials are assumed to be transported 161 km by diesel truck to either a landfill or material reclamation facility (for recycling). Datasets representing disposal in a landfill and waste incineration are from Ecoinvent.

The PCR requires the results for several inventory flows related to construction products to be reported including energy and resource use and waste and outflows. These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted taking into account this limitation.

3.6 CUT-OFF RULES

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.

3.7 DATA SOURCES

Primary data were provided for the manufacturing facility. The sources of secondary LCI data are the Ecoinvent database.

Table 7. *Data sources for the Merge Forward Polypropylene Composite Tile flooring products.*

Component	Dataset	Data Source	Publication Date
PRODUCT			
PP			
Polypropylene	polypropylene production, granulate | polypropylene, granulate | Cutoff, S/RoW	EI v3.9	2022
Filler			
Calcium Carbonate	limestone production, crushed, washed | limestone, crushed, washed | Cutoff, S/RoW	EI v3.9	2022
Underlayment			
Polyethylene	polyethylene production, low density, granulate | polyethylene, low density, granulate | Cutoff, S/RoW	EI v3.9	2022
Stabilizer			
Stabilizer	chemical production, inorganic | chemical, inorganic | Cutoff, S/GLO	EI v3.9	2022
	chemical production, organic | chemical, organic | Cutoff, S/GLO	EI v3.9	2022
Other			
Flame retardant, Coatings	graphite production | graphite | Cutoff, S/RoW	EI v3.9	2022
	chemical production, inorganic | chemical, inorganic | Cutoff, S/GLO	EI v3.9	2022
	chemical production, organic | chemical, organic | Cutoff, S/GLO	EI v3.9	2022
	polyurethane production, flexible foam, MDI-based | polyurethane, flexible foam | Cutoff, S/RoW	EI v3.9	2022
PACKAGING			
Cardboard	containerboard production, linerboard, testliner | containerboard, linerboard | Cutoff, S/RoW	EI v3.9	2022
Plastic	packaging film production, low density polyethylene | packaging film, low density polyethylene | Cutoff, S/RoW	EI v3.9	2022
	polypropylene production, granulate | polypropylene, granulate | Cutoff, S/RoW	EI v3.9	2022
Wood	EUR-flat pallet production | EUR-flat pallet | Cutoff, S/RoW	EI v3.9	2022
TRANSPORT			
Road transport	transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, S/RoW	EI v3.9	2022
Ship transport	transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, S/GLO	EI v3.9	2022
RESOURCES			
Grid electricity - Japan	market for electricity, medium voltage | electricity, medium voltage | Cutoff, S/JP	EI v3.9	2022
Steam	market for heat, from steam, in chemical industry | heat, from steam, in chemical industry | Cutoff, S/RoW	EI v3.9	2022

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3.8 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 8. *Data quality assessment for the flooring 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. 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 2021-2022.
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 regional power mixes from the Ecoinvent LCI database. Surrogate data used in the assessment are representative of global or North American operations. Data representative of global operations are considered sufficiently similar to actual processes. Data representing product and packaging 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 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 flooring 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 v3.9 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	Data representing energy use at manufacturing facility represent 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 v3.9 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 all 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.

3.9 PERIOD UNDER REVIEW

The LCA results are based on annual production data for 2021-2022.

3.10 ALLOCATION

Manufacturing resource use was allocated to the products based on surface area. Impacts from transportation were allocated based on the mass of material and distance transported.

The Merge Forward Polypropylene Composite Tile flooring 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.

3.11 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 flooring products to the point of installation is included in the assessment based on information provided by the manufacturer. Transportation parameters for modeling transport to consumer markets are summarized in Table 9.

Table 9. *Product distribution parameters by transport mode.*

Parameter	Unit	Value
Truck Transport		
Fuel type	-	Diesel
Liters of fuel	L/100km	18.7
Vehicle type	-	Diesel truck
Transport distance	km	1,500
Capacity utilization	%	76
Gross density of products transported	kg/m^3	1,271
Weight of products transported	kg	5.72
Ocean Transport		
Fuel type	-	Fuel oil
Liters of fuel	L/tkm	2.23
Vehicle type	-	Ocean freighter
Transport distance	km	18,000
Capacity utilization	%	70
Gross density of products transported	kg/m^3	1,271
Weight of products transported	kg	5.72

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Installation of the product is accomplished using hand tools with no associated emissions and negligible impacts. The impacts associated with packaging disposal are included with the installation phase as per PCR requirements.

Table 10. *Installation parameters for the flooring products, per 1 m^2 (A5).*

Parameter	Value
Ancillary materials	-
Net freshwater consumption (m^3)	-
Electricity consumption (kWh)	-
Product loss per functional unit (kg)	negligible
Waste materials generated by product installation (kg)	negligible
Output materials resulting from on-site waste processing (kg)	na
Direct emissions (kg)	-
Mass of packaging waste (kg)	
Corrugated/Paper	8.00×10^{-2}
Plastic	2.04×10^{-3}
Wood	0.150
Biogenic carbon in packaging (kg CO_2)	0.422
VOC emissions	negligible

Use stage (B1)

No impacts are associated with the use of the product over the Reference Service Lifetime.

Maintenance stage (B2)

According to the manufacturer, typical maintenance involves regular sweeping and damp mopping of the flooring. The present assessment is based on a recommended weekly cleaning schedule including sweeping and mopping with a neutral cleaner.

Table 11. *Maintenance parameters for the flooring products, per 1 m^2.*

Parameter	Unit	Value
Maintenance process	-	Damp mopping
Net freshwater consumption	$m^3/m^2/yr$	0.0058
Cleaning agent	$kg/m^2/yr$	0.119
Further assumptions	-	Moderate traffic

Repair/Refurbishment stage (B3; B5)

Product repair and refurbishment are not relevant during the lifetime of the product.

Replacement stage (B4)

The materials and energy required for replacement of the product over the 75-year estimated service lifetime of the assessment are included in this stage. Modeling parameters for the product replacement stage are summarized in Table 12.

Table 12. *Product replacement parameters for the flooring products, per 1 m^2.*

Parameter	Value	Units
Reference service life	10	Years
Replacement cycle	6.5	-
Energy input	-	kWh
Freshwater consumption	-	m^3
Ancillary materials	-	kg
Replacement parts	37.2	kg
Direct emissions	-	kg

Building operation stage (B6 – B7)

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

Disposal stage (C1 - C4)

At end-of-life, the product is assumed to be disposed in a landfill per PCR requirements. Assumptions for end-of-life for the packaging are based on regional statistics regarding municipal solid waste generation and disposal, including end-of-life recycling rates of packaging and product materials. As per the PCR, 10% of the packaging materials are recycled while the remaining materials are landfilled at end-of-life.

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. No recycling of the product materials is assumed at end-of-life. The relevant disposal parameters used for the product system are summarized in Table 13.

Table 13. *End-of-life disposal scenario parameters for the flooring product.*

Parameter	Value
Assumptions for scenario development	100% landfill
Collection process	
Collected with mixed construction waste (kg)	5.49
Recovery	n/a
Landfill disposal (kg)	5.49
Removals of biogenic carbon (kg CO_2 eq)[1]	n/a

[1] *excluding 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. All LCA results are stated to three significant figures in agreement with the PCR for this flooring product and therefore the sum of the total values may not exactly equal 100%.

The following environmental impact category indicators are reported using characterization factors based on the U.S. EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts – TRACI 2.1 and CML-IA.

CMLI-A Impact Category	Unit	TRACI 2.1 Impact Category	Unit
Global Warming Potential **(GWP)**	kg CO_2 eq	Global Warming Potential **(GWP)**	kg CO_2 eq
Depletion potential of the stratospheric ozone layer **(ODP)**	kg CFC 11 eq	Ozone Depletion Potential **(ODP)**	kg CFC 11 eq
Acidification Potential of soil and water **(AP)**	kg SO_2 eq	Acidification Potential **(AP)**	kg SO_2 eq
Eutrophication Potential **(EP)**	kg PO_4^{3-} eq	Eutrophication Potential **(EP)**	kg N eq
Photochemical Oxidant Creation Potential **(POCP)**	kg C_2H_4 eq	Smog Formation Potential **(SFP)**	kg O_3 eq
Abiotic depletion potential **(ADP-elements)** for non-fossil resources	kg Sb eq	Fossil Fuel Depletion Potential **(ADP_{fossil})**	MJ Surplus, LHV
Abiotic depletion potential **(ADP-fossil fuels)** for fossil resources	MJ, 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, B3, B5, B6 and B7 are not associated with any impact and are therefore declared as zero. In addition, module C1 is likewise not associated with any impact as the floor is manually deconstructed. Additionally, as the flooring products do not typically 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 14. *Life Cycle Impact Assessment (LCIA) results for the* ***Merge Forward Polypropylene Composite Tile*** *flooring 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	B2	B4	C2	C4
CML-IA									
GWP (kg CO_2 eq)	6.61	0.128	1.64	2.72	0.173	17.6	93.2	1.22	1.85
	5.3%	0.1%	1.3%	2.2%	0.14%	14%	75%	0.97%	1.5%
AP (kg SO_2 eq)	2.34×10^{-2}	8.85×10^{-4}	3.91×10^{-3}	3.14×10^{-2}	2.27×10^{-4}	7.19×10^{-2}	0.423	4.81×10^{-3}	5.26×10^{-4}
	4.2%	0.16%	0.7%	5.6%	0.041%	13%	76%	0.86%	0.094%
EP (kg $(PO_4)^{3-}$ eq)	5.94×10^{-3}	1.48×10^{-4}	3.87×10^{-3}	4.27×10^{-3}	6.00×10^{-4}	1.81×10^{-2}	0.233	1.09×10^{-3}	1.99×10^{-2}
	2.1%	0.052%	1.4%	1.5%	0.21%	6.3%	81%	0.38%	6.9%
POCP (kg C_2H_4 eq)	1.49×10^{-3}	3.14×10^{-5}	3.28×10^{-4}	9.67×10^{-4}	3.52×10^{-5}	4.32×10^{-3}	2.24×10^{-2}	2.09×10^{-4}	3.88×10^{-4}
	4.9%	0.1%	1.1%	3.2%	0.12%	14%	74%	0.69%	1.3%
ODP (kg CFC-11 eq)	3.95×10^{-8}	1.68×10^{-9}	1.55×10^{-8}	3.51×10^{-8}	7.00×10^{-10}	8.11×10^{-8}	7.10×10^{-7}	1.53×10^{-8}	1.43×10^{-9}
	4.4%	0.19%	1.7%	3.9%	0.078%	9%	79%	1.7%	0.16%
ADPF (MJ eq)	207	1.75	11.2	36.2	0.727	454	1,780	15.8	1.55
	8.2%	0.07%	0.45%	1.4%	0.029%	18%	71%	0.63%	0.062%
TRACI 2.1									
GWP (kg CO_2 eq)	6.50	0.127	1.50	2.70	0.148	17.3	89.1	1.21	1.53
	5.4%	0.11%	1.3%	2.2%	0.12%	14%	74%	1%	1.3%
AP (kg SO_2 eq)	2.44×10^{-2}	9.86×10^{-4}	3.98×10^{-3}	3.41×10^{-2}	2.89×10^{-4}	7.34×10^{-2}	0.459	6.11×10^{-3}	6.53×10^{-4}
	4.1%	0.16%	0.66%	5.7%	0.048%	12%	76%	1%	0.11%
EP (kg N eq)	1.09×10^{-2}	1.27×10^{-4}	9.43×10^{-3}	2.87×10^{-3}	1.54×10^{-3}	3.32×10^{-2}	0.520	6.40×10^{-4}	5.45×10^{-2}
	1.7%	0.02%	1.5%	0.45%	0.24%	5.3%	82%	0.1%	8.6%
SFP (kg O_3 eq)	0.306	2.11×10^{-2}	5.16×10^{-2}	0.678	8.20×10^{-3}	0.904	8.18	0.183	1.25×10^{-2}
	3%	0.2%	0.5%	6.5%	0.079%	8.7%	79%	1.8%	0.12%
ODP (kg CFC-11 eq)	4.89×10^{-8}	2.21×10^{-9}	1.91×10^{-8}	4.63×10^{-8}	9.33×10^{-10}	1.21×10^{-7}	9.08×10^{-7}	2.04×10^{-8}	1.95×10^{-9}
	4.2%	0.19%	1.6%	4%	0.08%	10%	78%	1.7%	0.17%
FFD (MJ eq)	29.6	0.251	1.16	5.22	0.109	62.7	253	2.39	0.206
	8.3%	0.071%	0.33%	1.5%	0.031%	18%	71%	0.67%	0.058%

Table 15. *Resource use and waste flows for the* ***Merge Forward Polypropylene Composite Tile*** *flooring 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.*

Parameter	A1	A2	A3	A4	A5	B2	B4	C2	C4
Resources									
RPR_E (MJ)	2.71	$2.10x10^{-2}$	6.44	0.390	$4.81x10^{-3}$	11.6	62.9	$6.27x10^{-2}$	$5.36x10^{-2}$
	3.2%	0.025%	7.6%	0.46%	0.0057%	14%	75%	0.074%	0.064%
RPR_M (MJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0%	0%	0%	0%	0%	0%	0%	0%	0%
$NRPR_E$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA	INA
$NRPR_M$ (MJ)	INA	INA	INA	INA	INA	INA	INA	INA	INA
SM (kg)	0.769	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
	13%	0%	0%	0%	0%	0%	87%	0%	0%
RSF/NRSF (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
RE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
FW (m^3)	0.235	$1.26x10^{-3}$	$6.18x10^{-2}$	$2.32x10^{-2}$	$3.46x10^{-4}$	0.985	2.15	$5.66x10^{-3}$	$2.70x10^{-3}$
	6.8%	0.036%	1.8%	0.67%	0.01%	28%	62%	0.16%	0.078%
Wastes									
HWD (kg)	$6.53x10^{-5}$	$1.11x10^{-5}$	$3.53x10^{-5}$	$2.16x10^{-4}$	$4.83x10^{-6}$	$2.74x10^{-4}$	$2.92x10^{-3}$	$1.08x10^{-4}$	$9.05x10^{-6}$
	1.8%	0.3%	0.97%	5.9%	0.13%	7.5%	80%	3%	0.25%
NHWD (kg)	0.353	$7.36x10^{-2}$	1.12	1.16	0.213	1.19	55.3	$8.03x10^{-2}$	5.51
	0.54%	0.11%	1.7%	1.8%	0.33%	1.8%	85%	0.12%	8.5%
HLRW (kg)	$9.82x10^{-6}$	$9.85x10^{-8}$	$4.13x10^{-6}$	$1.82x10^{-6}$	$2.60x10^{-8}$	$4.27x10^{-5}$	$1.07x10^{-4}$	$3.44x10^{-7}$	$2.85x10^{-7}$
	5.9%	0.059%	2.5%	1.1%	0.016%	26%	64%	0.21%	0.17%
ILLRW (kg)	$2.25x10^{-5}$	$2.35x10^{-7}$	$1.73x10^{-5}$	$4.33x10^{-6}$	$6.34x10^{-8}$	$9.94x10^{-5}$	$2.99x10^{-4}$	$8.14x10^{-7}$	$7.25x10^{-7}$
	5.1%	0.053%	3.9%	0.98%	0.014%	22%	67%	0.18%	0.16%
CRU (kg)	0.00	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	$2.32x10^{-2}$	0.00	0.151	0.00	0.00
	0%	0%	0%	0%	13%	0%	87%	0%	0%
MER (kg)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
EE (MJ)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

6. LCA: Interpretation

The contributions to total impact indicator results are dominated by the product replacement phase of the assessment. With few exceptions, of the remaining life cycle phases, the product use and maintenance phase is the highest contributor followed by raw material extraction and processing, product distribution and product disposal.

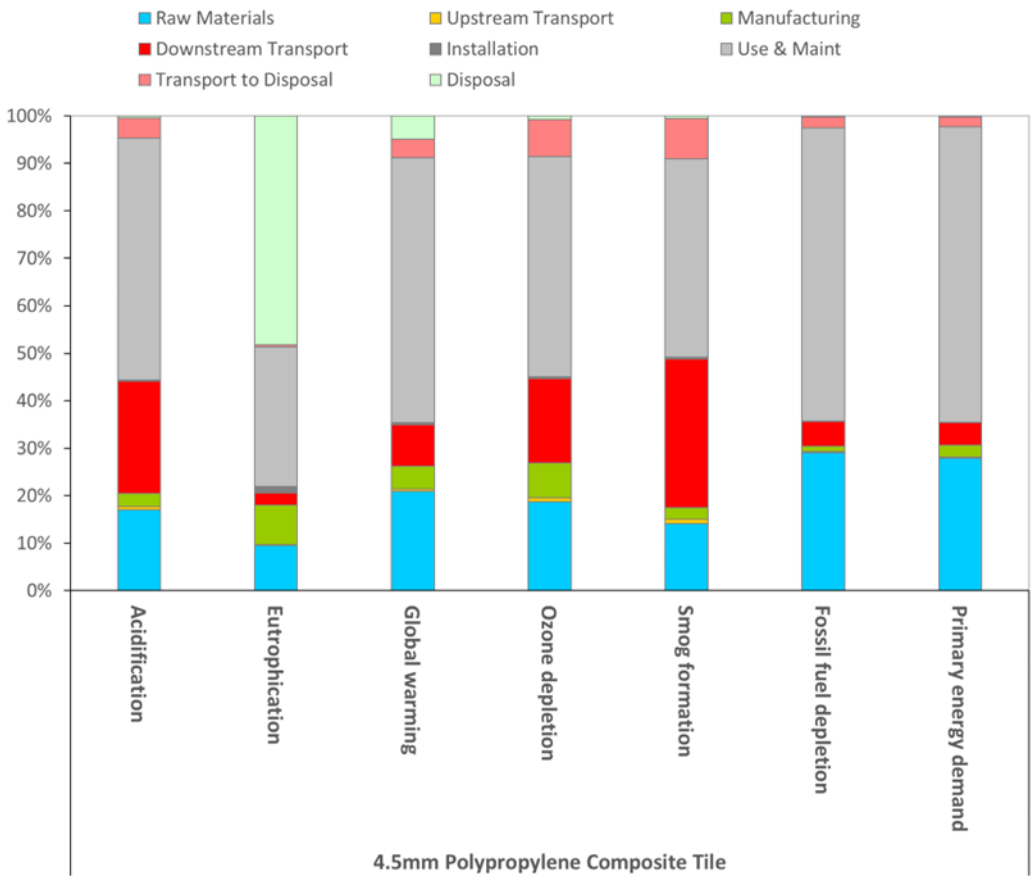

Figure 2. *Contribution analysis for the flooring products – TRACI 2.1. (excluding product replacements).*

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