EF Contract

VERIFIED by SCS GLOBAL SERVICES ENVIRONMENTAL PRODUCT DECLARATION BASED ON LCA

Declaration Owner

EF Contract
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Product

EF Contract LVT

Functional Unit

The functional unit is one square meter of floor covering provided and maintained for a period of 60 years.

EPD Number and Period of Validity

SCS-EPD-05574
EPD Valid June 14, 2019 through June 13, 2024

Product Category Rule

Product Category Rule (PCR) for preparing an Environmental Product Declaration (EPD) for Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International. Version 2. 2014.

Program Operator

SCS Global Services
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SCSglobal SERVICES

Declaration Owner:	EF Contract
Address:	1501 Coronet Drive, Dalton, GA 30720
Declaration Number:	SCS-EPD-05574
Declaration Validity Period:	EPD Valid June 14, 2019 through June 13, 2024
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:	SimaPro 8.3
Independent critical review of the LCA and data, according to ISO 14044	☒ internal ☐ external
LCA Reviewer:	Jeremie Hakian, SCS Global Services
Product Category Rule:	Product Category Rule (PCR) for preparing an Environmental Product Declaration (EPD) for Flooring: Carpet, Resilient, Laminate, Ceramic, Wood. NSF International. Version 2. 2014.
PCR Review conducted by:	Jack Geibig (chairperson), Ecoform; jgeibig@ecoform.com
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
Declaration Contents:	

Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and ISO 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.

ABOUT EF Contract

EF Contract (EFC) is part of the fastest-growing, most progressive family of flooring companies, Engineered Floors. We stand for confidence in quality, relentless service and doing right by all. Our products are inspired by you: offering the carpet and hard-surface flooring that you want and need, that you've been seeking but unable to find, until now. Every collection, pattern and colorway are created with best in class performance and in pursuit of design that is simply beautiful. That guiding ethic continues today as EF Contract strives to positively impact our associates, customers and community on a daily basis. By putting our people first, we produce products with pride, provide value to our customers and make a difference in our community. Our commitment to our associates and their families, as well as our larger community, requires EF Contract to provide gainful employment and economic development. In 2018, EF Contract joined Engineered Floors, LLC. Based in Dalton, Ga., Engineered Floors, LLC is a privately held carpet producer founded by Robert E. Shaw in 2009 and based in Dalton, Ga., with facilities in Calhoun and Dalton, Ga. Engineered Floors employs 4000 people.

PRODUCT DESCRIPTION

EF Contract's collection of easy to install luxury vinyl tile flooring products along with our other flooring products, gives us a complete flooring solution to offer our customers. Our high performance LVT products have commercial grade backing and can withstand heavy amounts of traffic. These products are phthalate free with recycled raw material and produced by using green energy in efficient manufacturing environments that can boast 100% recycling capability. Products are available in plank and tile format and the customer can choose from styles that mimic natural wood, concrete and stone finishes. Durability is assured with a UV cured urethane finish.

This EPD includes products with specifications of the following wear layers and thicknesses respectively; 3.0 mm/12 mil and 5.0 mm/20 mil.

The composition within the LVT family of products does not differ other than pigments used to give each style of LVT its own distinct appearance. This variation is less than 5% of the total product weight and is excluded from the study.

PRODUCT APPLICATION

EF Contract LVT is suitable for shopping malls, schools, large retail stores, department stores, buildings, restaurants, and hospitals.

PRODUCT PERFORMANCE

Table 1. *Product performance test results for EF Contract LVT (3mm).*

Test Method	Test Description	Specification	Test Results
ASTM F2055	Tile Size	With grain: ± 0.096″	Pass
		Against grain: ± 0.014″	Pass
ASTM 2055	Tile Squareness	≤ 0.010″	Pass
ASTM F386	Total Product Thickness	±0.127 mm	Pass
ASTM F410	Wear Layer Thickness	Type 1 Grade 1	Pass
ASTM D3884	Taber Abrasion	≤ 0.100 % @ 1,000 Cycles	Pass
ASTM E648	Critical Radiant Flux	Class I	Pass
ASTM E662	Smoke Density-Flaming	< 450 (Corrected Max Density)	Pass
ASTM E662	Smoke Density-Non Flaming	< 450 (Corrected Max Density)	Pass
ASTM F1914	Short Term Indentation	Avg. ≤ 8%	Pass
ASTM F970	Static Load 1,500 psi	≤ 0.005″	Pass
ASTM F137	Flexibility	No Break or Crack	Pass
ASTM F2199	Dimensional Stability	With grain: ≤0.0800″	Pass
		Against grain:≤0.0117″	Pass
ASTM D2047	Static Coefficient of Friction	≥0.50	Pass
ASTM F1515	Lightfastness 300 hrs	< 8 ΔE	Pass
Phillips	Rolling Chair 25,000	≤ Slight Disturbance	Pass
ASTM F925	Resistance to Chemicals	≤ Slight Surface Change	Pass
ASTM F1514	Heat Stability	< 8 ΔE	Pass
ASTM D2240	Shore Hardness	As Received	---
ASTM F1265	Impact Resistance	No Break or Crack (Wet & Dry)	Pass
ASTM F1304	Deflection	≥ 25.4 mm	Pass

Table 2. *Product performance test results for EF Contract LVT (5mm).*

Test Method	Test Description	Specification	Test Results
ASTM F2055	Tile Size	With grain: ± 0.096″	Pass
		Against grain: ± 0.014″	Pass
ASTM 2055	Tile Squareness	≤ 0.010″	Pass
ASTM F386	Total Product Thickness	±0.127 mm	Pass
ASTM F410	Wear Layer Thickness	Type 1 Grade 1	Pass
ASTM D3884	Taber Abrasion	≤ 0.100 % @ 1,000 Cycles	Pass
ASTM E648	Critical Radiant Flux	Class I	Pass
ASTM E662	Smoke Density-Flaming	< 450 (Corrected Max Density)	Pass
ASTM E662	Smoke Density-Non Flaming	< 450 (Corrected Max Density)	Pass
ASTM F1914	Short Term Indentation	Avg. ≤ 8%	Pass
ASTM F970	Static Load 1,500 psi	≤ 0.005″	Pass
ASTM F137	Flexibility	No Break or Crack	Pass
ASTM F2199	Dimensional Stability	With grain: ≤0.0800″	Pass
		Against grain:≤0.0117″	Pass
ASTM D2047	Static Coefficient of Friction	≥0.50	Pass
ASTM F1515	Lightfastness 300 hrs	< 8 ΔE	Pass
ASTM F2753	Rolling Chair 25,000	≤ Slight Disturbance	Pass
ASTM F925	Resistance to Chemicals	≤ Slight Surface Change	Pass
ASTM F1514	Heat Stability	< 8 ΔE	Pass
ASTM D2240	Shore Hardness	As Received	---
ASTM F1265	Impact Resistance	No Break or Crack (Wet & Dry)	Pass
ASTM F1304	Deflection	≥ 25.4 mm	Pass

MATERIAL CONTENT

Table 3. *Origin and availability of material content for EF Contract LVT (3mm).*

Component	Materials	Origin of Raw Material	Availability			Pre- and Post-Consumer Recycled Content	Percent of Total
			Renewable	Non-Renewable	Recycled		
Calcium Carbonate	Filler - natural, ground CaCO3	Global		Mineral, Abundant			16%
Recycle PVC Scrap Powder	Recycled polyvinyl chloride	Global			Fossil, Limited	0%/100%	35%
Recycle PVC Scrap Chip	Recycled polyvinyl chloride	Global			Fossil, Limited	100%/10%	24%
PVC	Polyvinyl chloride	Global		Fossil, Limited			17%
Plasticizer	Plasticizer – DOTP mixture	Global		Fossil, Limited			3.4%
Glass Fiber	Glass fiber, pulp, acrylate	Global		Mineral, Abundant; Fossil, Limited			-
Stabilization	Ba-Zn organic liquid complex	Global		Fossil, Limited			0.69%
UV Resin Coating	Hydroxyethyl acrylate, organic compounds	Global		Fossil, Limited			0.41%
Pigment	Carbon black, zinc oxide, $CaCO_3$, PVC, DOTP	Global		Fossil, Limited			0.08%
Packaging	Corrugated board	Global	Abundant				2.4%
Packaging	Wood pallet	Global	Abundant				1.9%

Table 4. *Origin and availability of material content for EF Contract LVT (5mm).*

Component	Materials	Origin of Raw Material	Availability			Pre- and Post-Consumer Recycled Content	Percent of Total
			Renewable	Non-Renewable	Recycled		
Calcium Carbonate	Filler - natural, ground CaCO3	Global		Mineral, Abundant			39%
Recycle PVC Scrap Powder	Recycled polyvinyl chloride	Global			Fossil, Limited	0%/100%	30%
Recycle PVC Scrap Chip	Recycled polyvinyl chloride	Global			Fossil, Limited	100%/10%	12%
PVC	Polyvinyl chloride	Global		Fossil, Limited			8.0%
Plasticizer	Plasticizer – DOTP mixture	Global		Fossil, Limited			5.2%
Glass Fiber	Glass fiber, pulp, acrylate	Global		Mineral, Abundant; Fossil, Limited			0.76%
Stabilization	Ba-Zn organic liquid complex	Global		Fossil, Limited			0.51%
UV Resin Coating	Hydroxyethyl acrylate, organic compounds	Global		Fossil, Limited			0.23%
Pigment	Carbon black, zinc oxide, $CaCO_3$, PVC, DOTP	Global		Fossil, Limited			0.09%
Packaging	Corrugated board	Global	Abundant				2.0%
Packaging	Wood pallet	Global	Abundant				1.9%

The following regulated hazardous chemicals may be present based on a review of Material Safety Data Sheets for the product component materials:

- Calcium Carbonate (CAS# 471-34-1)
- Carbon Black (CAS# 1333-86-4)
- 1,4-Benzenedicarboxylate (CAS# 3198-30-9)
- bis(2-ethylhexyl)terephthalate (CAS# 6422-86-2)
- Fiber Glass Continuous Filament (CAS# 65997-17-3)

PRODUCTION OF MAIN MATERIALS

Calcium Carbonate: An abundant mineral found worldwide and a common substance found in rocks. It can be ground into varying particle sizes and used as inert filler.

Glass Paper (Fiber): Nonwoven glass scrim comprised of chopped glass and cellulose fibers and binder. Its major ingredients are silica sand, limestone, soda ash, and petrochemicals.

Polyvinyl Chloride (PVC): Derived from fossil fuel and salt. Petroleum or natural gas is processed to make ethylene, and salt is subjected to electrolysis to separate out the natural element chlorine. Ethylene and chlorine are combined to produce ethylene dichloride, which is further processed into a gas called vinyl chloride monomer (VCM). Polymerization of VCM molecules form chains, converting the gas into fine, white powder—vinyl resin.

Plasticizer: Plasticizers are used to make vinyl soft and flexible. Diisononyl phthalate (DINP) was used in the life cycle assessment model to represent plasticizers used to manufacture products covered by this EPD such as Diisooctyl terephthalate (DOTP).

Stabilizers: Stabilizers (typically metal compounds) are used to prevent the chain reaction of decomposition which occurs as PVC is heated to soften during the extrusion or molding process. Stabilizers also provide enhanced resistance to daylight, weathering and heat aging and have an important influence on the physical properties of PVC. The main constituents are metal soaps, metal salts and organometallic compounds. The major metals contained in stabilizers include lead (Pb), barium (Ba), calcium (Ca), and tin (Sn) and are classified into Pb stabilizers, Ba-Zn stabilizers, Ca-Zn stabilizers, and Sn stabilizers

Pigment: A compounded mixture of pigment (e.g., carbon black, titanium dioxide) and a polymer carrier used as a colorant.

UV Resin (coating): A UV coating composed of photo-curable oligomer, photo initiator, reactive acrylic monomer and additives. It has excellent adhesion to PVC substrate and is a UV coating for PVC which provides scratch resistance, crack resistance, chemical resistance and abrasion resistance.

PRODUCT CHARACTERISTICS

Table 5. *Product characteristics for EF Contract LVT (3mm.*

Characteristics		Average Value	Unit	Maximum Value	Minimum Value
Product Thickness		3.0 (0.118)	mm (in)	4.0 (0.157)	2.0 (0.079)
Wear Layer Thickness		0.3 (0.012)	mm (in)	0.7 (0.028)	0.1 (0.004)
Product Weight		5,000 (16)	g/m^2 (oz/ft^2)	7,030 (23)	3,480 (11)
Product Form (Tiles)	Width	184 (7.2)	mm (in)	229 (9.0)	152 (6.0)
	Length	950 (37)	mm (in)	1,219 (48)	914 (36)
VOC Emissions Test Method		FloorScore®			
Sustainable Certifications		ISO 14001; CE			

Table 6. *Product characteristics for EF Contract LVT (5mm).*

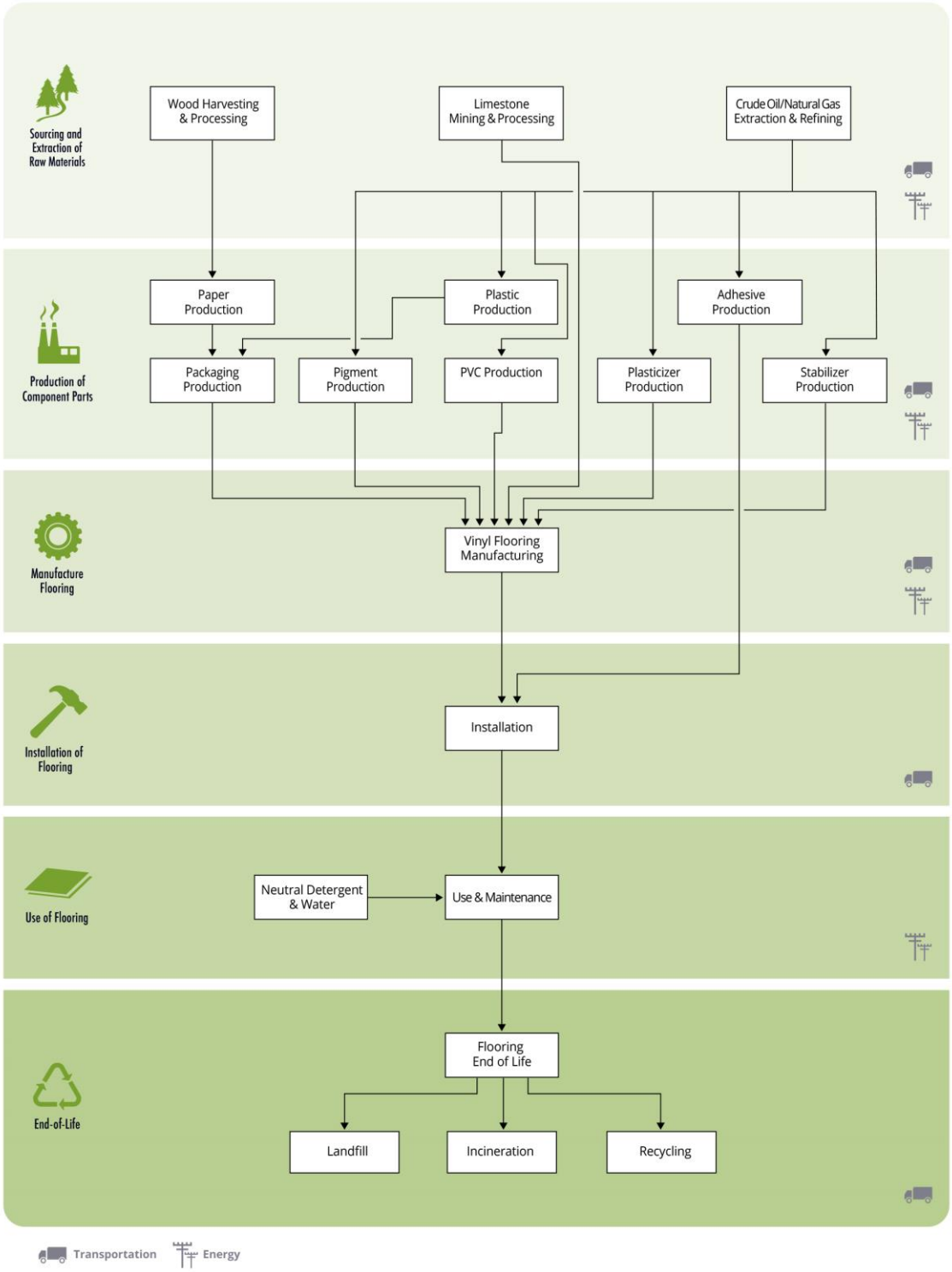
Characteristics		Average Value	Unit	Maximum Value	Minimum Value
Product Thickness		5.0 (0.197)	mm (in)	5.0 (0.197)	4.5 (0.177)
Wear Layer Thickness		0.5 (0.020)	mm (in)	0.7 (0.028)	0.3 (0.012)
Product Weight		8,760 (29)	g/m^2 (oz/ft^2)	8,990 (29)	7,890 (26)
Product Form (Tiles)	Width	178 (7.0)	mm (in)	229 (9.0)	152 (6.0)
	Length	1,219 (48)	mm (in)	1,219 (48)	914 (36)
VOC Emissions Test Method		FloorScore®			
Sustainable Certifications		ISO 14001; CE			

LIFE CYCLE ASSESSMENT

A cradle to grave life cycle assessment (LCA) was completed for this product group in accordance with ISO 14040, ISO 14044, ISO 21930, and Product Category Rule for Environmental Product Declarations for Flooring: Carpet, Resilient, Laminate, Ceramic, Wood (Version 2).

PRODUCT LIFE CYCLE FLOW DIAGRAM

The diagram below is a representation of the most significant contributions to the life cycle of EF Contract LVT. This includes resource extraction and processing, product manufacture, use and maintenance, and end-of-life.



FUNCTIONAL UNIT

The functional unit is, according to the PCR, the total impact for the expected life of the building (60 years). But the service life is dependent on the product lifetime, which is 10 years in this case. The PCR consequently requires separate reporting of LCA results A) for 1 m^2 of floor covering - extraction/processing, manufacturing, delivery and installation and end of life, B) the average 1- year use stage, and C) for the 60 year life of the building as combined using A) and B), calculated from the reference service life (RSL) of the product.

LIFE CYCLE ASSESSMENT STAGES AND REPORTED INFORMATION

Sourcing/Extraction Stage (raw material acquisition)

This stage includes extraction of virgin materials and reclamation of non-virgin feedstock. Resource use and emissions associated with both extraction of the raw materials and manufacture of carpet components are included.

Manufacturing Stage

EF Contract LVT is manufactured in an ISO 14001 certified facility in Chungcheongnam-do, Republic of Korea.

This stage includes all the relevant manufacturing processes and flows, including packaging. Production of capital goods, infrastructure, production of manufacturing equipment, and personnel-related activities are not included.

Delivery and Installation Stage

Delivery

This stage includes the delivery of the flooring product to the point of installation. Modeling used in the life cycle assessment assumed an estimated distribution distance to point of sale of 5,200 km by trans-oceanic ship and 2,500 km via diesel truck, representing transport across the United States.

Installation

EF Contract LVT is installed with the *Commercialon® Premium* LVT adhesive, as recommended, or a similar adhesive. The recommended application rate is 220 mL per square meter (0.22 kg/m^2).

Waste

Waste generated during product installation can be disposed of in a landfill, incinerated, or recycled.

Packaging

Table 7. *Packaging material for EF Contract LVT. Results are shown per 1 m^2 flooring.*

Material	*3mm LVT*		*5mm LVT*	
	Amount (kg)	Percent of Total	Amount (kg)	Percent of Total
Corrugated board	0.12	55%	0.18	51%
Wood pallet	$9.6x10^{-2}$	45%	0.18	49%

Use Stage

Cleaning and maintenance

Table 8. *Cleaning and maintenance for EF Contract LVT.*

Cleaning Process	Cleaning and Maintenance Frequency	Frequency over 10 year Reference Service Life (RSL)	Energy & Resource Use
Dust mop	Weekly (52 d/y)	520 times	None
Damp mop / neutral cleaner	Weekly (52 d/y)	520 times	Hot water

End-of-Life Stage

Recycling, reuse, or repurpose

Data for estimation of recycling rates for the product and packaging are taken from 2014 statistics regarding municipal solid waste generation and disposal in the United States, from the US Environmental Protection Agency. For product materials, it is assumed that 4% are recycled, while recycling rates for the product packaging materials vary, depending on waste material type.

Recycling, reuse, or repurpose

For disposal of product materials which are not recycled, it is assumed that 20% are incinerated and 80% go to a landfill. Transportation of waste materials at end of life assumes a 20 mile average distance to disposal, consistent with assumptions used in the US EPA WARM model.

LIFE CYCLE INVENTORY

In accordance with ISO 21930, the following aggregated inventory flows are included in the LCA, in addition to the LCIA and inventory flow requirements specified by the PCR:

- Use of renewable material resources
- Consumption of freshwater
- Hazardous Waste
- Non-hazardous Waste

All results are calculated using the SimaPro 8.3 model using primary and secondary inventory data. Classification for Use of Renewable Material Resources is based on review of elementary flows and resources considered renewable on a human time scale. Elementary flows related to use of wood, minerals, and land occupation were not included. Water consumption is also not included as this is reported separately. Based on this classification process, no renewable material resources are estimated for the product system under consideration.

Table 9. *Results for aggregated inventory flows, shown in kg per 1 m^2 of flooring maintained for 60 years.*

Parameter	EF Contract LVT – 3mm	EF Contract LVT – 5mm	Unit
Freshwater consumption	6.2	11	kg
Hazardous wastes	$2.2x10^{-3}$	$4.3x10^{-3}$	kg
Non-hazardous wastes	45	81	kg

LIFE CYCLE IMPACT ASSESSMENT

Life cycle impact assessment is the process of converting the life cycle inventory results into a representation of environmental and human health impacts. For example, emissions such as carbon dioxide, methane, and nitrous oxide (inventory) together contribute to climate change (impact assessment). The impact assessment for the EPD is conducted in accordance with requirements of the PCR. Impact category indicators are estimated using the CML (2013) characterization method. Aggregated inventory flows for energy use and wastes are also calculated. The LCIA and inventory flow results are calculated using SimaPro 8.3 software.

Table 10. *Cradle to install and end of life for EF Contract LVT (3mm). Results are shown per 1 m^2 flooring for an average 1-year time horizon. (Table A of the PCR)*

Impact Category	Units	Extraction & Processing	Manufacturing	Delivery & Installation	Disposal	Total
Global Warming Potential, 100 year time horizon	kg CO_2 eq	3.7 29%	2.6 20%	3.0 23%	3.4 27%	13 100%
Acidification Potential	kg SO_2 eq	$1.3x10^{-2}$ 31%	$7.6x10^{-3}$ 18%	$1.7x10^{-2}$ 41%	$4.3x10^{-3}$ 10%	$4.2x10^{-2}$ 100%
Eutrophication Potential	kg PO_4^{3-} eq	$2.7x10^{-3}$ 10%	$5.4x10^{-3}$ 20%	$3.3x10^{-3}$ 12%	$1.6x10^{-2}$ 58%	$2.7x10^{-2}$ 100%
Photochemical Ozone Creation Potential	kg C_2H_4	$7.2x10^{-4}$ 32%	$3.3x10^{-4}$ 15%	$7.9x10^{-4}$ 36%	$3.8x10^{-4}$ 17%	$2.2x10^{-3}$ 100%
Ozone Depletion Potential	kg CFC-11 eq	$1.6x10^{-7}$ 13%	$2.0x10^{-7}$ 16%	$5.1x10^{-7}$ 41%	$3.6x10^{-7}$ 30%	$1.2x10^{-6}$ 100%
Abiotic Depletion Potential, Elements	kg Sb eq	$9.8x10^{-3}$ 11%	$7.3x10^{-2}$ 78%	$9.1x10^{-3}$ 10%	$1.3x10^{-3}$ 1.4%	$9.3x10^{-2}$ 100%
Abiotic Depletion Potential, Fossil Fuels	MJ	89 50%	30 17%	49 28%	9.3 5.2%	180 100%
Renewable Energy	MJ	1.8 26%	3.4 48%	0.88 12%	0.97 13.6%	7.1 100%
Non-renewable Energy	MJ	100 50%	41 20%	51 25%	11 5.2%	210 100%

Table 11. *Average 1 year use stage impacts for EF Contract LVT (3mm) per 1 m^2 flooring. (Table B of the PCR)*

Impact Category	Units	Use & Maintenance
Global Warming Potential, 100 year time horizon	kg CO_2 eq	$2.3x10^{-2}$
Acidification Potential	kg SO_2 eq	$1.1x10^{-4}$
Eutrophication Potential	kg PO_4^{3-} eq	$4.5x10^{-5}$
Photochemical Ozone Creation Potential	kg C_2H_4	$8.1x10^{-6}$
Ozone Depletion Potential	kg CFC-11 eq	$2.1x10^{-9}$
Abiotic Depletion Potential, Elements	kg Sb eq	$1.6x10^{-2}$
Abiotic Depletion Potential, Fossil Fuels	MJ	0.42
Renewable Energy	MJ	$6.3x10^{-2}$
Non-renewable Energy	MJ	0.45

Table 12. *Life cycle stage impacts for EF Contract LVT (3mm) per 1 m^2 flooring over an average building life of 60 years. (Table C of the PCR)*

Impact Category	Units	Extraction & Processing	Manufacturing	Delivery & Installation	Use	Disposal	Total
Global Warming Potential, 100 year time horizon	kg CO_2 eq	22 29%	15 20%	18 23%	1.4 1.8%	21 27%	78 100%
Acidification Potential	kg SO_2 eq	$7.8x10^{-2}$ 30%	$4.5x10^{-2}$ 17%	0.10 40%	$6.7x10^{-3}$ 2.6%	$2.6x10^{-2}$ 9.9%	0.26 100%
Eutrophication Potential	kg PO_4^{3-} eq	$1.6x10^{-2}$ 9.88%	$3.2x10^{-2}$ 19%	$2.0x10^{-2}$ 12%	$2.7x10^{-3}$ 1.6%	$9.4x10^{-2}$ 57%	0.16 100%
Photochemical Ozone Creation Potential	kg C_2H_4	$4.3x10^{-3}$ 31%	$2.0x10^{-3}$ 14%	$4.8x10^{-3}$ 35%	$4.8x10^{-4}$ 3.5%	$2.3x10^{-3}$ 16%	$1.4x10^{-2}$ 100%
Ozone Depletion Potential	kg CFC-11 eq	$9.8x10^{-7}$ 13%	$1.2x10^{-6}$ 16%	$3.1x10^{-6}$ 40%	$1.3x10^{-7}$ 1.7%	$2.2x10^{-6}$ 29%	$7.5x10^{-6}$ 100%
Abiotic Depletion Potential, Elements	kg Sb eq	$5.9x10^{-2}$ 3.82%	0.44 28%	$5.4x10^{-2}$ 3.5%	0.98 64%	$8.0x10^{-3}$ 0.52%	1.5 100%
Abiotic Depletion Potential, Fossil Fuels	MJ	530 49%	180 17%	300 27%	25 2.3%	56 5.1%	1,100 100%
Renewable Energy	MJ	11 23%	21 45%	5.3 11%	3.8 8.2%	5.8 13%	46 100%
Non-renewable Energy	MJ	630 49%	250 19%	300 24%	27 2.1%	64 5.1%	1,300 100%

Table 13. *Cradle to install and end of life for EF Contract LVT (5mm). Results are shown per 1 m^2 flooring for an average 1-year time horizon. (Table A of the PCR)*

Impact Category	Units	Extraction & Processing	Manufacturing	Delivery & Installation	Disposal	Total
Global Warming Potential, 100 year time horizon	kg CO_2 eq	5.2 24%	5.1 23%	5.1 23%	6.6 30%	22 100%
Acidification Potential	kg SO_2 eq	$2.1x10^{-2}$ 29%	$1.5x10^{-2}$ 21%	$3.0x10^{-2}$ 42%	$6.0x10^{-3}$ 8.4%	$7.1x10^{-2}$ 100%
Eutrophication Potential	kg PO_4^{3-} eq	$4.7x10^{-3}$ 9.8%	$1.1x10^{-2}$ 22%	$5.5x10^{-3}$ 11%	$2.7x10^{-2}$ 57%	$4.8x10^{-2}$ 100%
Photochemical Ozone Creation Potential	kg C_2H_4	$1.1x10^{-3}$ 28%	$6.4x10^{-4}$ 16%	$1.3x10^{-3}$ 33%	$9.0x10^{-4}$ 23%	$3.9x10^{-3}$ 100.0%
Ozone Depletion Potential	kg CFC-11 eq	$3.4x10^{-7}$ 16%	$3.9x10^{-7}$ 19%	$8.9x10^{-7}$ 43%	$4.6x10^{-7}$ 22%	$2.1x10^{-6}$ 100%
Abiotic Depletion Potential, Elements	kg Sb eq	$1.3x10^{-2}$ 8.9%	0.12 80%	$1.5x10^{-2}$ 10%	$1.9x10^{-3}$ 1.3%	0.15 100%
Abiotic Depletion Potential, Fossil Fuels	MJ	130 45%	59 21%	83 29%	13 4.6%	280 100%
Renewable Energy	MJ	2.7 24%	6.1 54%	1.3 12%	1.2 11%	11 100%
Non-renewable Energy	MJ	140 44%	81 25%	85 26%	15 4.6%	320 100%

Table 14. *Average 1 year use stage impacts for EF Contract LVT (5mm). per 1 m^2 flooring. (Table B of the PCR)*

Impact Category	Units	Use & Maintenance
Global Warming Potential, 100 year time horizon	kg CO_2 eq	$2.3x10^{-2}$
Acidification Potential	kg SO_2 eq	$1.1x10^{-4}$
Eutrophication Potential	kg PO_4^{3-} eq	$4.5x10^{-5}$
Photochemical Ozone Creation Potential	kg C_2H_4	$8.1x10^{-6}$
Ozone Depletion Potential	kg CFC-11 eq	$2.1x10^{-9}$
Abiotic Depletion Potential, Elements	kg Sb eq	$1.6x10^{-2}$
Abiotic Depletion Potential, Fossil Fuels	MJ	0.42
Renewable Energy	MJ	$6.3x10^{-2}$
Non-renewable Energy	MJ	0.45

Table 15. *Life cycle stage impacts for EF Contract LVT (5mm). per 1 m^2 flooring over an average building life of 60 years. (Table C of the PCR)*

Impact Category	Units	Extraction & Processing	Manufacturing	Delivery & Installation	Use	Disposal	Total
Global Warming Potential, 100 year time horizon	kg CO_2 eq	31 24%	31 23%	31 23%	1.4 1.0%	40 30%	130 100%
Acidification Potential	kg SO_2 eq	0.12 28%	$8.9x10^{-2}$ 21%	0.18 41%	$6.7x10^{-3}$ 1.5%	$3.6x10^{-2}$ 8.3%	0.43 100%
Eutrophication Potential	kg PO_4^{3-} eq	$2.8x10^{-2}$ 9.7%	$6.3x10^{-2}$ 22%	$3.3x10^{-2}$ 11%	$2.7x10^{-3}$ 0.93%	0.16 56%	0.29 100%
Photochemical Ozone Creation Potential	kg C_2H_4	$6.6x10^{-3}$ 28%	$3.8x10^{-3}$ 16%	$7.7x10^{-3}$ 32%	$4.8x10^{-4}$ 2.0%	$5.4x10^{-3}$ 22%	$2.4x10^{-2}$ 100%
Ozone Depletion Potential	kg CFC-11 eq	$2.0x10^{-6}$ 16%	$2.4x10^{-6}$ 19%	$5.4x10^{-6}$ 42%	$1.3x10^{-7}$ 1.0%	$2.8x10^{-6}$ 22%	$1.3x10^{-5}$ 100%
Abiotic Depletion Potential, Elements	kg Sb eq	$7.9x10^{-2}$ 4.2%	0.71 38%	$8.8x10^{-2}$ 4.7%	0.98 53%	$1.2x10^{-2}$ 0.62%	1.9 100%
Abiotic Depletion Potential, Fossil Fuels	MJ	760 44%	360 21%	500 29%	25 1.5%	78 4.5%	1,700 100%
Renewable Energy	MJ	16 23%	37 51%	8.0 11%	3.8 5.3%	7.5 10%	72 100%
Non-renewable Energy	MJ	860 44%	490 25%	510 26%	27 1.4%	89 4.5%	2,000 100%

SUPPORTING TECHNICAL INFORMATION

Unit processes are developed with SimaPro 8.3 software, drawing upon data from multiple sources. Primary data were provided by EF Contract's supplier for their manufacturing processes. The primary sources of secondary LCI data are from Ecoinvent Database.

Table 16. *Data sources used for the LCA study.*

Component	Material Description	Material Dataset	Data Source	Publication Date
Product				
Polyvinyl chloride (PVC)	Polyvinyl chloride (PVC)	Polyvinylchloride, emulsion polymerised {GLO} | market for | Alloc Rec	EI v3.3	2016
Recycle PVC Scrap Powder	Recycled PVC	Polyvinylchloride, recycled, post-consumer {GLO} | market for | Alloc Rec	EI v3.3	2016
Recycle PVC Scrap Chip	Recycled PVC	Polyvinylchloride, recycled, pre-consumer {GLO} | market for | Alloc Rec	EI v3.3	2016
Plasticizer	Plasticizer (DOTP mixture)	2-ethylhexyl phthalate (DEHP) {GLO} | market for | Alloc Rec	EI v3.3; Overcash	2016; 2014
Filler ($CaCO_3$)	Natural, ground CaCO3	Limestone, crushed, for mill {GLO} | market for | Alloc Rec	EI v3.3	2016
Glass Paper	Glass fibre	Glass fibre {GLO}| market for | Alloc Rec	EI v3.3	2016
	Cellulose fibre	Cellulose fibre, inclusive blowing in {GLO}| market for | Alloc Rec	EI v3.3	2016
	Vinyl acetate	Vinyl acetate {GLO}| market for | Alloc Rec	EI v3.3	2016
Pigment	Carbon black	Carbon black {GLO} | market for | Alloc Rec	EI v3.3	2016
	$CaCO_3$ filler	Limestone, crushed, washed {RoW}| market for limestone, crushed, washed | Alloc Rec	EI v3.3	2016
	Zinc Oxide	Zinc oxide {GLO}| market for | Alloc Rec	EI v3.3	2016
	Dioctyl Terephthalate	Chemical, organic {GLO}| market for | Alloc Rec	EI v3.3	2016
	Polymer carrier	Polyvinylchloride, bulk polymerised {GLO}| market for | Alloc Rec	EI v3.3	2016
UV Resin	Coating	Chemical, organic {GLO}| market for | Alloc Rec	EI v3.3	2016
Stabilizer	Ba-Zn complex	Chemical, inorganic {GLO}| market for chemicals, inorganic | Alloc Rec	EI v3.3	2016
Packaging				
Packaging	Corrugated board	Corrugated board box {GLO}| market for corrugated board box | Alloc Rec	EI v3.3	2016
Packaging	Wood pallet	Wood pallet (22kg)/ RER	EI v2.2	2010
Transportation				
Road transport	Diesel Truck	Transport, freight, lorry 16-32 metric ton, EURO4 {GLO}| market for | Alloc Rec	EI v3.3	2016
Ship transport	Transoceanic Ship	Transport, freight, sea, transoceanic ship {GLO}| market for | Alloc Rec	EI v3.3	2016

Data Quality

Table 17. *Data quality assessment for the LCA study.*

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 10 years old (typically 2015). 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 annualized production for 2016.
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 Republic of Korea. 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 US 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 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. In total, these missing data represent less than 5% of the mass or energy flows.
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 v3.2 data where available. Different portions of the product life cycle are equally considered; however, it must be noted that final disposition of the product is based on assumptions of current average practices in the United States.
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 EF Contract's supplier's 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 datasets, Ecoinvent v2.2 and v3.3 LCI data are used, with a bias towards Ecoinvent v3.3 data.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the flooring products and packaging is low. Actual supplier data for upstream operations was not available for all suppliers 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.

Allocation

Resource use at the manufacturing facilities in South Korea (e.g., water and energy) was allocated to the product based on the unit price as a fraction of the total facility sales.

The flooring products include recycled materials, which are 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.

Impacts from transportation were allocated based on the mass of material and distance transported.

System boundaries

The system boundary of the life cycle assessment for vinyl tile products was cradle to grave. A description of the system boundaries for this study are as follows:

- **Sourcing/extraction stage** – This stage includes extraction of virgin materials and reclamation of non-virgin feedstock. Resource use and emissions associated with both extraction of the raw materials product component manufacturing are included. Upstream transportation is also included.
- **Manufacturing stage** – This stage includes all the relevant manufacturing processes and flows, including packaging. Production of capital goods, infrastructure, production of manufacturing equipment, and personnel related activities are not included.
- **Delivery and installation stage** – This stage includes the delivery of the vinyl tile products to the point of installation.
- **Use stage** – The use stage includes the cleaning and maintenance of the floor covered during its lifetime, as well as extraction, manufacturing and transport of all sundry material for maintenance and cleaning.
- **End of life stage** – The end of life stage includes the transport of the floor covering to end of life processes including landfill, incineration, and recycling.

Cut-off criteria

According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact must be included in the inventory. In the present study, except as noted, all known materials and processes were included in the life cycle inventory.

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