ENVIRONMENTAL PRODUCT DECLARATION

NOVALIS HIGH PERFORMANCE CORE (HPC)

NOVALIS INNOVATIVE FLOORING

NOVALIS HIGH PERFORMANCE CORE (HPC)

NOVALIS
INNOVATIVE FLOORING

Novalis Innovative Flooring began making Luxury Vinyl Tile (LVT) in 1984. Novalis flooring is now sold in over 50 countries across six continents.

The products of Novalis® run the gamut of styles, installation methods and applications, including residential, commercial, hospitality, education, healthcare, retail, and more.

Since the very beginning, Novalis® has led the LVT industry in the adoption of the highest manufacturing standards and sustainable practices to ensure a quality flooring product that is kind to the environment — both indoors and outdoors.

Novalis brings unsurpassed quality in its aesthetic design and manufacturing for the commercial market. This attention to quality also extends to its care for the environment, bringing green processes, standards and environmental protection into its category-leading sustainability program.

For more information visit:
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UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

Environmental Product Declaration

NOVALIS
INNOVATIVE FLOORING

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ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

NOVALIS
High Performance Core (HPC)

According to ISO 14025, EN 15804, and ISO 21930:2017

EPD Program and Program Operator Name, Address, Logo, and Website	UL Environment 333 Pfingsten Road Northbrook, IL 60611 https://www.ul.com/ https://spot.ul.com
General Program Instructions and Version Number	General Program Instructions v.2.1 April 2017
Manufacturer Name and Address	Decoria Materials (JiangSu) Co.,Ltd. No.63, GuangYuan Road, Dantu Industrial Park, Zhenjiang, JiangSu Province, P.R. China
Declaration Number	4789201527.103.1
Declared Product & Functional Unit or Declared Unit	Novalis High Performance Core (HPC); 1 m^2
Reference PCR and Version Number	Product Category Rules for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements, *Standard 10010, Version 3.2* Part B: Flooring EPD Requirements, *UL 10010-7, Version 2.0*
Description of product application/use	LVT for commercial and residential spaces
Product RSL Description	Commercial: 10 Years Residential: 25 Years
Markets of Applicability	Global; EN; North America
Date of Issue	January 1, 2020
Period of Validity	5 Years
EPD Type	Product-Specific
Range of Dataset Variability	N/A
EPD Scope	Cradle-to-grave
Year(s) of reported primary data	July 2018 – June 2019
LCA Software & Version Number	SimaPro 9
LCI Database(s) & Version Number	Ecoinvent 3, Ecoinvent 3- CN, USLCI, ELCD
LCIA Methodology & Version Number	CML-IA (baseline) & TRACI

This PCR review was conducted by:	UL Environment PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Grant R. Martin, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas Gloria, Industrial Ecology Consultants

Limitations

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

1. Product Definition and Information

1.1 Description of Company/Organization

As the owner of AVA® commercial LVT, NovaFloor LVT, and other brands, Novalis is one of the largest producers of Luxury Vinyl Tile (LVT) flooring in the world. Novalis was established in 1984 and distributes its LVT flooring in over 50 countries across six continents. Novalis is a member of the North American Association of Floor Covering Distributors (NAFCD), the Resilient Floor Covering Institute (RFCI), World Floor Covering Association (WFCA), Multilayer Modular Flooring Association (MMFA), Multilayer Flooring (MLF), U.S. Green Building Council (USGBC), and International WELL Building Institute (IWBI). The Vision of the company encompasses three essential characteristics:

- Art
  By offering rich, authentic reproductions of wood, stone, and other designs in striking, eye-catching patterns and giving the ability to combine these colors and textures to create imaginative, inspiring spaces.

- Quality
  By increasing investment in research and development to bring the latest in LVT product performance to the flooring market while offering industry-leading product guarantees.

- Nature
  By conserving energy and resources while reducing the carbon footprint of the products and operations. Novalis recognizes the utmost importance of considering environmental impacts in the design and production of all its flooring products.

The Novalis factory has been awarded certificates for compliance with the following standards:

- ISO 9001:2015 - Quality Management System
- ISO 14001:2015 - Environmental Management System
- OHSAS 18001:2007 - Occupational Health and Safety Management System

1.2 Product Description

1.2.1 Product Identification

Novalis High Performance Core (HPC) luxury vinyl flooring is a rigid and floating floor system that can be installed with minimal subfloor preparation. It has a commercial wear layer for commercial use. Installation is easy with an angle-drop locking system, and the product offers improved acoustic performance. Novalis HPC is waterproof and has strong scratch resistance.

1.2.2 Product Specification

Novalis HPC features a wide range of beautiful flooring options for many applications. Some Novalis HPC products include an attached cork backing, which greatly improves its sound reduction characteristics without requiring the use of a separate sound control product. It is constructed with a waterproof core, a durable wear layer and proprietary AMP (Aminomethyl Propanol) polyurethane coating, making it an ideal flooring product for multi-family units, condominiums, corporate offices and a variety of other residential and light commercial environments.

The following figure shows the construction of the HPC flooring.

NOVALIS INNOVATIVE FLOORING

NOVALIS
High Performance Core (HPC)

According to ISO 14025, EN 15804 and ISO 21930:2017

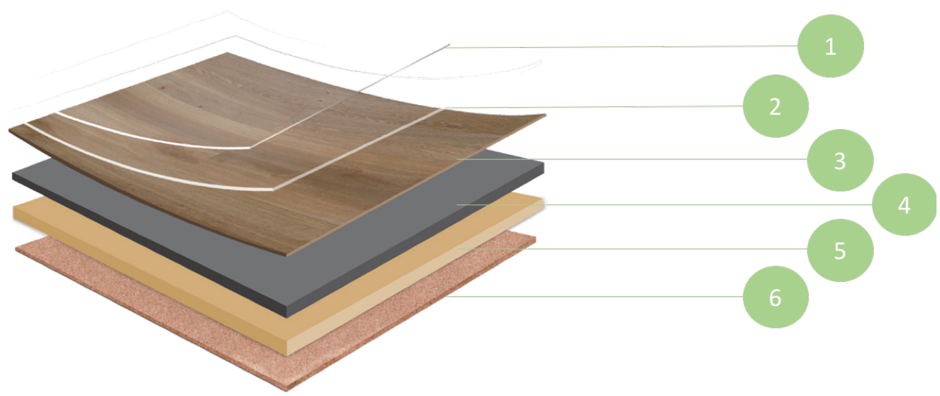

Figure 1. Construction of Novalis High Performance Core (HPC)

1. **AMP Coating:** Coating that increases scratch- and scuff-resistance, has excellent stain- and fade-resistance properties, is easy to maintain, and eliminates the need for wax
2. **Transparent Wear Layer:** Extremely durable wear layer that gives HPC its long commercial and residential use life
3. **Printed Wear Layer:** Design layer that gives the floor its unique pattern and color
4. **Base Layer:** Vinyl layer produced with a soybean oil plasticizer, highly resistant to pressure
5. **Extruded Vinyl Core:** High performance waterproof core that improves rigidity and overall stability of the product
6. **Pre-Attached Cork Underlayment:** Underlayment that improves acoustic performance and increases comfort underfoot

Table 1. Technical Specifications of Novalis High Performance Core (HPC)

STANDARDS	RESULTS
ASTM F3261 – RIGID POLYMERIC CORE FLOORING	CLASS I, TYPE B, GRADE 1, BACKING CLASS B
ASTM F1914 - RESIDUAL INDENTATION	PASSES, <0.007 IN.
ASTM F1914 – SURFACE INTEGRITY	PASSES, NO PUNCTURE
ISO 23999 - DIMENSIONAL STABILITY	PASSES, <0.2% PER LIN. FT
ISO 23999 - CURLING	PASSES, <0.08 IN.
ASTM F925 - CHEMICAL RESISTANCE	PASSES
ASTM F1514 - HEAT COLOR STABILITY	PASSES, < ∆8E
ASTM F1515 - LIGHT COLOR STABILITY	PASSES, < ∆8E
ASTM F970 - STATIC LOAD LIMIT	PASSES, 250 LBS.
ASTM E648 (NFPA 253) - CRITICAL RADIANT FLUX	CLASS I, >0.45 W/CM^2
ASTM E662 (NFPA 258) - SMOKE DENSITY	PASSES, <450
ASTM D2047 - SLIP RESISTANCE	>0.6 (DRY)
ASTM E492/E989 – IMPACT SOUND	IIC 54*, 56‡, 52◊
ASTM E90 / E413 – AIRBORNE SOUND	STC 50*, 52‡, 60◊
ASTM E2179 - DELTA IIC	∆21*
CHPS / CA SECTION 01350	COMPLIANT

1.2.3 Product-Specific EPD

This declaration is for Novalis High Performance Core (HPC) flooring. The "6.5 (0.55) HPC with Cork Underlayment" specification is the representative specification because it has the highest annual production amount. 6.5 (0.55) means the thickness of the product is 6.5 mm and the thickness of its wear layer is 0.55 mm. In the Life-Cycle Assessment LCA study, each specification was analyzed, and the LCA results were presented separately. However, only the LCA results of the representative specification are presented in this declaration.

While allocating energy and material usage within the production site, allocation was carried out based on either the average annual mass or average annual surface area produced.

1.3 Application

The products covered in this declaration are for use in corporate offices, retail spaces, residential spaces, hospitality, and a variety of other commercial environments.

1.4 Declaration of Methodological Framework

In this project, a full LCA approach was considered with some simplification on data modeling using generic data for most background systems. The EPD analysis uses a cradle-to-grave system boundary. No known flows are deliberately excluded from this EPD.

To calculate the LCA results for the product maintenance stage, a 10- or 25-year reference service life (RSL) was assumed for the declared products. HPD tiles with wear layers no thinner than 0.55mm will be used for commercial purposes with a RSL of 10 years, and the rest will be considered for residential use with a RSL of 25 years.

Additional details on assumptions, cut-offs and allocation procedures can be found in section 2.4, 2.5, and 2.9, respectively.

1.5 Technical Requirements

Novalis High Performance Core (HPC) products offer a wide range of beautiful flooring options in various specifications for many applications. Therefore, the following technical data provides a range of values for each parameter.

Table 2. Technical Data for Novalis High Performance Core (HPC)

Name			Average Value	Min Value	Max Value	Unit
PRODUCT THICKNESS			-	5.0	8.0	MM
WEAR LAYER THICKNESS (WHERE APPLICABLE)			-	0.30	0.70	MM
PRODUCT WEIGHT			-	6105.2	8824.2	G/M^2
PRODUCT FORM	ROLLS	WIDTH	-	-	-	MM
		LENGTH	-	-	-	M
	TILES		-	298.5 x 603.3	450.9 x 908.1	MM
	PLANKS		-	146.1 x 1212.9	235.0 x 1815.0	MM

1.6 Placing on the Market / Application Rules

Novalis transparently declares the composition and environmental impact of Novalis High Performance Core (HPC) products with a Health Product Declaration (HPD), Declare® label, and Environmental Product Declaration (EPD). In addition, Novalis High Performance Core (HPC) products also have the technical specifications shown in Table 1 and meet the criteria of the following certifications and standards:

- GREENGUARD Gold
- Indoor Advantage™ Gold
- FloorScore®
- REACH
- California Proposition 65

1.7 Material Composition

Table 3. Material Composition of Novalis High Performance Core (HPC)

COMPONENT	MATERIALS	HPC
Substrate - Plasticizer	**DOTP**	1.19% - 2.26%
Bio-based Plasticizer	**Octadecanoic acid**	1.61% - 4.18%
Substrate	**$CaCO_3$**	43.47% - 52.05%
Substrate	**Polyvinyl Chloride (PVC)**	34.81% - 39.62%
Stabilizer	**Calcium Stearate**	0.07% - 0.28%
Stabilizer	**Zinc Stearate**	0.06% - 0.21%
Stabilizer	**Epoxized Soybean Oil**	0.22% - 0.58%
Acrylic Processing Aid	**Acrylic**	1.75% - 2.56%
Impact Modifier	**Methylmethacrylate-butadiene-styreneco polymer resin**	0.36% - 0.63%
Stabilizing agent	**Ca-Zn complex stabilizer**	1.32% - 2.38%
Lubricant	**Oxidized polyethylene wax**	0.07% - 0.33%
Internal lubricant	**Stearic acid**	0.19% - 0.34%
Foaming agent	**Azodicarbonamide**	0.13% - 0.43%
Pigment	**Carbon Black**	0.02% - 0.06%
Film	**Titanium Dioxide**	0.05% - 0.07%
UV coating	**Urethane Acrylates**	0.20% - 0.30%
Pigment- Organic yellow	**2 - (c) tetrachlorophthalic anhydride - 8 (N) - tetrachlorophthalic anhydride quinoline**	0.02% - 0.04%
Backing	**IXPE (Irradiated cross-linked polyethylene)**	0% - 1.24%
Backing	**Cork**	0% - 2.89%
Adhesive	**Reactive polyurethane glue**	0.57% - 2.67%

The main raw materials used to produce Novalis High Performance Core (HPC) are polyvinyl chloride (PVC) resins and calcium carbonate ($CaCO_3$). In addition, a plasticizer, stabilizer, pigment, lubricant and other materials are used. As there are a range of Novalis High Performance Core (HPC) specifications, and some specifications are produced with an IXPE or cork acoustic backing, the component percentages are therefore presented with a range of values.

1.8 Manufacturing

The manufacturing process of Novalis High Performance Core (HPC) mainly includes preparing the base layer, undergoing lamination and continuous line processing, coating with a UV layer, gluing, cutting, profiling, and packaging.

The main raw materials used to produce Novalis High Performance Core (HPC) are polyvinyl chloride (PVC) resins and calcium carbonate ($CaCO_3$). During the production of the PVC base layer, these two materials are mixed with a plasticizer, stabilizer, and other materials. Once the compound is ready, a series of heated rollers are used to squeeze the compound into a continuous sheet with a precise width and thickness. After that, the sheet is sent through a cooling process and is ready for lamination. The different layers are bonded to each other through the lamination process. Engraved rollers are then used to apply a textured design onto the surface, which is followed by the application of the UV layer and passing through an annealing treatment in order to relieve the stress between the layers. Afterwards, the foam core and cork acoustic layer (when specified) are glued to the PVC base layer. Finally, the products are cut into pieces matching the specifications, and the edges are profiled. After a quality check, the products that pass are packaged for transportation.

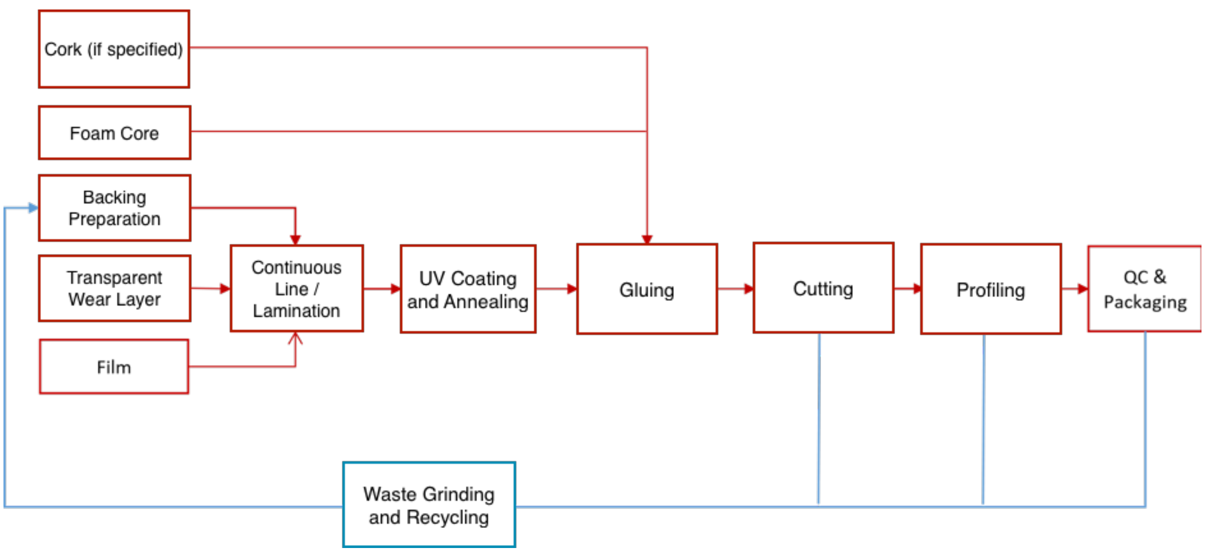

Figure 2. Production Process of Novalis High Performance Core (HPC)

1.9 Packaging

Cardboard and wood pallets are the main packaging materials for Novalis High Performance Core (HPC). According to Novalis, 99.44% of HPC products are purchased and used in the United States, and 0.56% are purchased and used in the United Kingdom. In the LCA study, the disposal of packaging materials adopted a rough country- and region-based weighted average disposal model following the UL PCR for Building-Related Products and Services Part A Section 2.8.5. A sensitivity analysis on packaging disposal scenarios was also conducted.

1.10 Transportation

According to Novalis, the majority of HPC products are purchased and used in the United States and United Kingdom. Oceanic and road transportation distance for product delivery was estimated with reference to external resources. Table 8 demonstrates the data used for stage A4 in the LCA modelling.

1.11 Product Installation

Novalis High Performance Core (HPC) flooring allows quick and easy installation with its drop-lock mechanism. The installation is completely glue free, and only a few tools such as cutting instruments (i.e. a knife or scissors) are necessary. As such tools are reusable, the production and disposal stage of any tools was omitted from the LCA study. According to Novalis' estimates, approximately 5% of the total material is cut off as waste during installation.

1.12 Use and Maintenance

After installation, very little effort is required in order to use HPC. However, routine vacuuming, cleaning and surface conditioning is required for regular maintenance and upkeep of the product. The cleaning schedule depends on multiple factors, including weight capacity, terminal function, the amount of dust entering the building, and more. For the purposes of this EPD, average maintenance is presented based on typical installations. The calculations are based off of the cleaning routine presented in Table 5.

1.13 Reference Service Life and Estimated Building Service Life

Novalis High Performance Core (HPC) flooring with a wear layer no thinner than 0.55mm has a RSL of 10 years for commercial purposes and a RSL of 25 years for residential use.

1.14 Reuse, Recycling, and Energy Recovery

Novalis has a partnership with a recycler in the U.S. for pre-consumer recycling of LVT flooring. Novalis is also currently working with its large retail customers to develop a take-back program for the reuse and recycling of LVT flooring that is no longer needed by end users. The goal of this strategy will be to employ methods both of rerouting the flooring for reuse and of grinding up and recycling the flooring to be used in the creation of Novalis flooring or other products, such as rubber hoses, car mats, speed bumps, paneling, and more.

1.15 Disposal

According to Novalis, 99.44% of HPC products are purchased and used in the United States, and 0.56% are purchased and used in the United Kingdom. For the LCA study, the disposal of the used HPC flooring adopted a country- and region-based weighted average disposal model following disposal routes and waste classification referenced in PCR part A section 2.8.5 and 2.8.6. This LCA used an end-of-life disposal treatment process (C4) from Ecoinvent and USLCI. The waste scenario assumed 100 km of road transportation (C2) from an installation site to a MSW treatment site.

2. Life Cycle Assessment Background Information

2.1 Functional or Declared Unit

In this study, the functional unit was defined as 1 (one) m^2 of Novalis High Performance Core (HPC) flooring.

Table 4. Functional Unit Information

NAME	VALUE	UNIT
FUNCTIONAL UNIT	1	m^2
MASS	6.11 – 9.19	kg

2.2 System Boundary

The life cycle stages considered in this LCA study are from cradle to grave.

The following stages have been assessed:

- A1-A3: Product stage (raw material acquisition, transport to manufacturing site and manufacturing)
- A4-A5: Construction stage (transport to user site, installation)
- B2: Maintenance
- C1-C4: End of life stage (deconstruction, transport, waste processing and disposal)

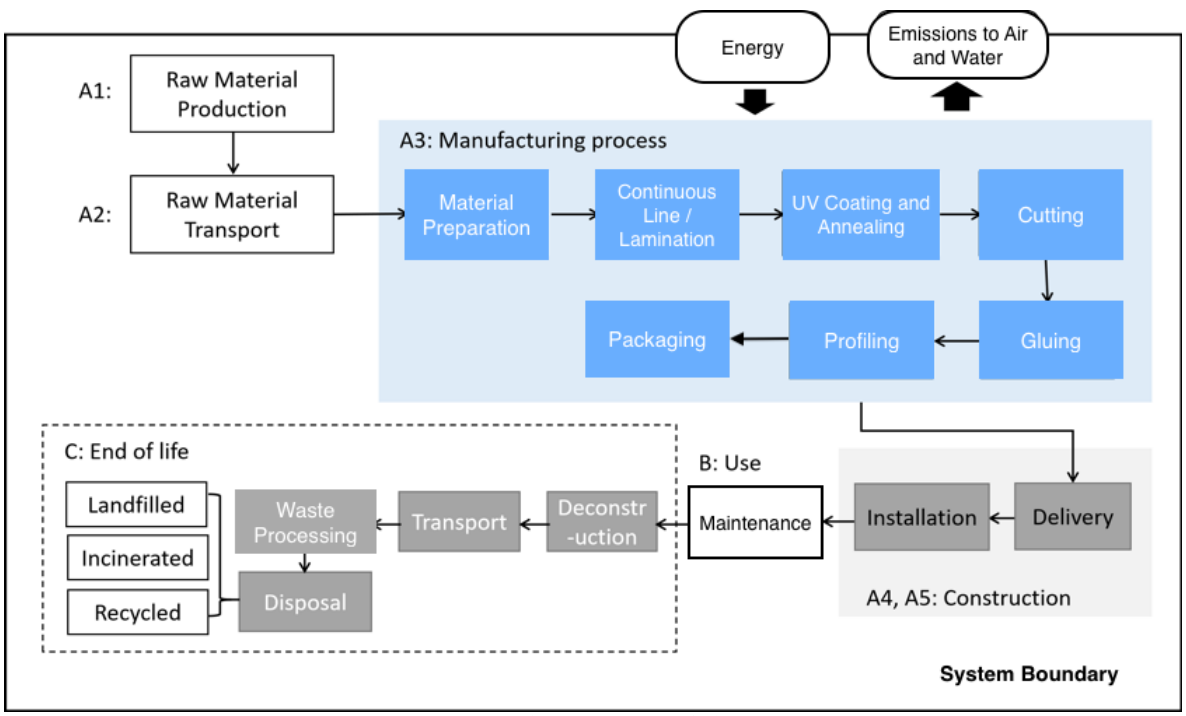

Figure 3. System Boundary of LCA study

The LCA study traced all energy and material inputs back to the extraction of resources for each life-cycle stage of the products. In addition, the study quantified emissions from the whole system, and included various waste management scenarios.

2.3 Product for Maintenance Phase (Modules B1-B7)

For the calculations of maintenance phase, the following cleaning routine was considered:

Table 5. Cleaning and Maintenance

Cleaning Process	Cleaning Frequency	Consumption of energy and resources
Vacuuming	weekly	Electricity
Mopping	weekly	Water and detergent

Table 6. Inputs in Maintenance Stage

	Amount	Units	Scenario
Water	5.20	L/m^2/year	Based on weekly vacuum and weekly mopping
Electricity	0.02	kWh/m^2/year	
Detergent	104.00	g/m^2/year	

2.4 Estimates and Assumptions

The main assumptions of this LCA study are as follows:

- The product description paper (1 page) included in the packaging contributes less than 0.1% to the total weight of the final product 's packaging and was therefore excluded from the analysis;
- The raw materials calcium stearate and zinc stearate were not in the background database, so they were substituted with stearic acid from the EI database;
- Background data for the raw material azodicarbonamide (a foaming agent) were not in the database, so it was substituted with N,N-dimethylformamide from the EI database;
- Background data for the impact modifier was not in the database, so it was substituted with polymethyl methacrylate from the EI database;
- Background data for the raw material oxidized polyethylene wax (a type of lubricant) was not in the database, so it was substituted with polyethylene from the EI database;
- The raw material organic yellow (a pigment) contributes less than 1% to the total mass of raw materials composing the substrate layer for HPC, so it was omitted from the analysis;
- As there is no specific metering or monitoring system on-site to track material flows in the factory, the distribution of water, natural gas, and electricity consumption during the production processes were calculated by the site engineer based on historical data and experience with operations;
- Similarly, since the consumption of power and water increase linearly with the mass of production, the distribution of energy, water, and natural gas usage during the production of various product specifications were modeled using a mass ratio allocation method. However, the ratio for the distribution of UV coating usage for various product specifications was calculated based on surface area, since surface area, not mass, is the relevant factor when UV coating is applied;
- Assumptions on transportation were made where it was not possible to obtain the specific data, such as the distance of oceanic transportation and inland transportation in the United States and other markets. When this occurred, it was clearly stated in the report, and a sensitivity analysis was conducted;
- The report makes assumptions for certain processes, such as maintenance, for which electricity and water consumption data were not obtained. The report clearly states when making assumptions such as this or others.

2.5 Cut-off Criteria

The following procedures were followed for the exclusion of inputs and outputs:

- All inputs and outputs to a (unit) process were included in the calculation where data was available. Data gaps were filled by conservative assumptions with average or generic data. Any assumptions for such choices were documented;
- In case of insufficient input data or data gaps for a unit process, according to the PCR requirement, the cut-off criteria chosen is 1% of renewable and non-renewable primary energy usage and 1% of the total mass of that unit process. The total neglected input flows of the cradle to grave stage, e.g. per module A1-A3, A4-A5, B1-B5, B6-B7, C1-C4 and module D shall be a maximum of 5% of energy usage and mass. In this study, the neglected flow is demonstrated in the table below.

Table 7. Cut-off Flows

FLOW NAME	PROCESS STAGE	MASS %	TOTAL MASS %
GLUE AND DESCRIPTION PACKAGING PAPER	PACKAGING	2.93E-05, <<1%	2.93E-05, <<1%
ORGANIC YELLOW (PIGMENT)	SUBSTRATE LAYER	0.02 – 0.04	0.02 – 0.04

Material and energy flows known to have the potential to cause significant emissions into air, water or soil related to the environmental indicators of this study were included in the assessment. After reviewing the Material Safety Data Sheets and relevant physical, chemical and other information of the flows listed in table above, no significant negative emission to the environment from above listed flows was identified.

Other processes that contribute to obviously less than 1% of overall mass and energy contribution were cut off, which include:

- Storage phases and sales of product
- Handling operations at the distribution center and retail outlet
- Secondary and transit packaging
- Transport from distribution warehouse to retail outlet and from retail outlet to consumer household or commercial center

2.6 Data Sources

The study used generic data from various sources, including scientific literature, public sources, and databases such as Ecoinvent, ELCD, Chinese LCI, USLCI, and others.

In the study, the key parameters for producer-specific foreground data were based on one year (July 2018 to June 2019) of averaged data from Novalis. The life-cycle inventory includes data collected from a variety of publicly available sources, taking into consideration the degree to which it was technologically, temporally and geographically representative. The study utilized the Chinese-regionalized LCI database to the greatest extent possible. In the event data was missing from or not available in the LCI database, the study referred to Ecoinvent and regional databases such as USLCI, ELCD and other relevant databases. The study then conducted sensitivity analyses to validate the data and outputs using realistic parameters.

2.7 Data Quality

The data quality requirements for this study were as follows:

- Existing LCI data were, at most, 10 years old. Newly collected LCI data were current or up to 3 years old;
- The LCI data related to the geographical locations where the processes took place, e.g. electricity and transportation data from China, disposal data in the United States, Europe, and etc. were utilized;
- The scenarios represented the average technologies at the time of data collection.

2.8 Period under Review

The study used primary data collected from July 2018 to June 2019.

2.9 Allocation

This study assumed that in-plant recycling for the production of the base layer was a closed loop, meaning that the study allocated all of the environmental impacts from the recycling of the base layer, cutting, and profiling scraps and all of the environmental benefits of using recycled material to avoid waste generation during the production of the base layer to the process of production.

To be conservative, the environmental benefits of recycling and energy recovery were not included in the study for the recycling and disposal processes at the end-of-life stage.

For process-related allocations, the study distinguished between multi-input and multi-output processes.

- Multi-input processes

  While allocating energy and auxiliary materials within the production site, allocation was carried out on the basis of either the average annual mass or the average annual surface area produced. The decision to use average annual mass or average annual surface area was based on the relationship of the input to the environmental impacts. In most cases, the input amount increases linearly with the mass of product produced. However, the amount of energy and materials used in the annealing and UV coating processes is proportional to the surface area of product produced. Accordingly, the allocation of energy and material related to these types of processes was based on surface area rather than mass.

- Multi-output processes

  In this study, there were no other by-products from the production line, therefore there were very few situations that required allocation from multi-output processes. For waste treatment, one allocation was carried out on the environmental emissions. In the end-of-life stage, the allocation within the disposal scenario was based on mass, which applies to the waste treatment process inventory that was adopted from the Ecoinvent data.

2.10 Comparability (Optional)

No comparisons or benchmarking are included in this EPD. LCA results across EPDs can be calculated with different background databases, modeling assumptions, geographic scope and time periods, all of which are valid and acceptable according to the Product Category Rules (PCR) and ISO standards. The user of the EPD should take care when comparing EPDs from different companies. Assumptions, data sources, and assessment tools may all impact the uncertainty of the final results and make comparisons misleading.

3. Life Cycle Assessment Scenarios

According to Novalis, 99.44% of HPC products are purchased and used in the United States, and 0.56% are purchased and used in the United Kingdom. The study estimated oceanic and road transportation distance for product delivery by referring to external resources. The table below demonstrates the data used for stage A4 in the LCA modelling.

Table 8. Transport to the Building Site (A4)

NAME	VALUE		UNIT
	ROAD	OCEAN	
Fuel type	DIESEL	HEAVY OIL	
Liters of fuel	31.11 l/100km	12.483 t/100km	l/100km or t/100km
Vehicle type	LORRY (32t)	SHIP (50000DWT)	
Transport distance	1000	24949	km
Capacity utilization (including empty runs, mass based	50	100	%
Gross density of products transported	1078	1078	kg/m^3
Capacity utilization volume factor (factor: =1 or <1 or ≥ 1 for compressed or nested packaging products)	0.4	0.4	-

Table 9. Installation into the Building (A5)

NAME	VALUE	UNIT
Ancillary materials	-	kg
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)	-	m^3
Other resources	-	kg
Electricity consumption	-	kWh
Other energy carriers	-	MJ
Product loss per functional unit	0.05	m^2/m^2
Waste materials at the construction site before waste processing, generated by product installation	0.05	m^2/m^2
Output materials resulting from on-site waste processing (specified by route; e.g. for recycling, energy recovery and/or disposal)	-	kg
Mass of packaging waste specified by type	Pulp: 0.229 Wood: 0.385 Plastic: 0.003 Metal: 0.00017	kg
Biogenic carbon contained in packaging	0.851	kg CO_2
Direct emissions to ambient air, soil and water	-	kg
VOC emissions	N/A	µg/m^3

Table 10. Reference Service Life

NAME	VALUE	UNIT
RSL	10 (Commercial use) 25 (Residential use)	years
Declared product properties (at the gate) and finishes, etc.	Luxury Vinyl Tile	m^2
Design application parameters (if instructed by the manufacturer), including references to the appropriate practices and application codes)	-	-
An assumed quality of work, when installed in accordance with the manufacturer's instructions	-	-
Outdoor environment, (if relevant for outdoor applications), e.g. weathering, pollutants, UV and wind exposure, building orientation, shading, temperature	-	-
Indoor environment, (if relevant for indoor applications), e.g. temperature, moisture, chemical exposure)	Prevent water and moisture from accumulating underneath walk-off mats	-
Use conditions, e.g. frequency of use, mechanical exposure.	Commercial / Residential use	-
Maintenance, e.g. required frequency, type and quality of replacement components	Weekly vacuuming Weekly mopping	-

Table 11. Maintenance (B2)

NAME	VALUE	UNIT
Maintenance process information (cite source in report)	Weekly vacuum and weekly mopping	-
Maintenance cycle	Weekly vacuum and weekly mopping	Cycles/ RSL
Net freshwater consumption specified by water source and fate (amount evaporated, amount disposed to sewer)	5.2 city water disposed to sewer	$L/m^2/year$
Ancillary materials specified by type (e.g. cleaning agent)	104 (cleaning agent)	$g/m^2/year$
Other resources	-	kg
Energy input, specified by activity, type and amount	Electricity consumption 0.018	$kWh/m^2/year$
Other energy carriers specified by type	-	kWh
Power output of equipment	-	kW
Waste materials from maintenance (specify materials)	-	kg
Direct emissions to ambient air, soil and water	-	kg
Further assumptions for scenario development (e.g. frequency and time period of use, number of occupants);	-	-

As mentioned above, the majority of Novalis High Performance Core (HPC) products are purchased and used in the United States and United Kingdom. The disposal of the used HPC products adopted a country- and region-based weighted average disposal model following disposal routes and waste classification referenced in PCR Part A Section 2.8.5 and 2.8.6. The LCA study used the end-of-life disposal treatment process (C4) from Ecoinvent and USLCI.

For the waste scenario, the study assumed a moderate distance of 100 km for the road transportation (C2) required from an installation site to a MSW treatment site. According to Novalis, the tile can be manually removed from the floor, so input and output were omitted for the deconstruction (C1) and waste processing (C3) stages. The table below displays the data used for stages C1-C4 in the LCA modeling.

Table 12. End-of-Life (C1-C4)

NAME		VALUE	UNIT
Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)		See description above	
Collection process (specified by type)	Collected separately	-	kg
	Collected with mixed construction waste	7.012	kg
Recovery (specified by type)	Reuse	-	kg
	Recycling	0.196	kg
	Landfill	6.087	kg
	Incineration	0.005	kg
	Incineration with energy recovery	-	kg
	Energy conversion efficiency rate	-	
Disposal (specified by type)	Product or material for final deposition	0	kg CO_2
Removals of biogenic carbon (excluding packaging)		0.420	kg CO_2

4. Life Cycle Assessment Results

Table 13. Description of the System Boundary Modules

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				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 supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
EPD Type: Cradle-to-grave	x	x	x	x	x	MND	x	MND	MND	MND	MND	MND	x	x	x	x	MND

4.1 Life Cycle Impact Assessment Results

To analyze the environmental impact of each process, a LCIA was conducted using the CML-IA baseline method and the TRACI method on the chosen representative HPC product **6.5 (0.55) HPC with Cork Underlayment** product. The result was allocated by stages, as shown in tables below. Note that the results are based on 10 years' usage, as the representative product will be used for commercial purposes.

Table 14. North American Impact Assessment (TRACI) Results for 6.5 (0.55) HPC with Cork Underlayment

Impact category (TRACI)	Unit	Production	Transport of product	Installation	Maintenance	Transport of waste	Disposal
		A1-A3	A4	A5	B2	C2	C4
Ozone depletion	kg CFC-11 eq	1.93E-06	1.45E-07	1.73E-09	2.38E-07	7.80E-08	2.64E-08
Global warming	kg CO_2 eq	1.96E+01	3.36E+00	8.21E-02	4.88E+00	9.28E-01	1.99E+00
Smog	kg O_3 eq	1.07E+00	8.16E-01	9.86E-04	1.71E-01	1.45E-01	1.51E-02
Acidification	kg SO_2 eq	1.03E-01	5.16E-02	5.00E-05	1.59E-02	5.04E-03	1.30E-03
Eutrophication	kg N eq	6.63E-02	2.52E-03	3.14E-03	3.04E-02	4.34E-04	4.52E-02
Carcinogenics	CTUh	8.36E-07	5.46E-08	6.53E-10	1.50E-07	6.42E-09	9.39E-08
Non carcinogenics	CTUh	5.34E-06	2.80E-07	2.31E-08	5.00E-07	6.37E-08	5.84E-06

Respiratory effects	kg PM2.5 eq	1.34E-02	3.15E-03	7.51E-06	4.27E-03	6.09E-04	1.43E-04
Ecotoxicity	CTUe	9.57E+01	5.13E+00	8.23E-01	3.20E+01	6.77E-01	4.44E+02
Fossil fuel depletion	MJ surplus	5.04E+01	5.99E+00	1.71E-02	1.72E+00	1.95E+00	2.55E-01

Table 15. EU Impact Assessment (CML) Results for 6.5 (0.55) HPC with Cork Underlayment

Impact category (CML)	Unit	Production	Transport of product	Installation	Maintenance	Transport of waste	Disposal
		A1-A3	A4	A5	B2	C2	C4
Abiotic depletion	kg Sb eq	4.24E-05	4.29E-07	7.43E-09	1.02E-05	3.65E-07	1.29E-07
Abiotic depletion (fossil fuels)	MJ	4.06E+02	4.67E+01	1.32E-01	1.72E+01	1.37E+01	2.10E+00
Global warming (GWP100a)	kg CO_2 eq	1.96E+01	3.36E+00	8.21E-02	4.88E+00	9.28E-01	1.99E+00
Ozone layer depletion (ODP)	kg CFC-11 eq	1.51E-06	1.10E-07	1.31E-09	2.06E-07	5.88E-08	2.01E-08
Human toxicity	kg 1.4-DB eq	5.87E+00	1.62E+00	1.75E-02	1.46E+00	1.40E-01	2.27E+00
Fresh water aquatic ecotox.	kg 1.4-DB eq	3.16E+00	4.45E-01	3.33E-02	1.21E+01	1.54E-02	1.01E+01
Marine aquatic ecotoxicity	kg 1.4-DB eq	1.31E+04	2.19E+03	6.47E+01	1.65E+03	7.76E+01	8.47E+03
Terrestrial ecotoxicity	kg 1.4-DB eq	4.99E-02	2.97E-03	1.45E-04	4.80E+00	3.12E-04	7.35E-03
Photochemical oxidation	kg C_2H_4 eq	5.82E-03	2.16E-03	2.20E-05	2.81E-03	1.61E-04	5.21E-04
Acidification	kg SO_2 eq	1.00E-01	5.01E-02	4.15E-05	1.42E-02	4.05E-03	7.41E-04
Eutrophication	kg $(PO_4)^{3-}$eq	3.32E-02	4.77E-03	1.14E-03	1.49E-02	8.30E-04	1.67E-02

* Zero input and output were assumed for deconstruction of the tile (C1) and waste processing (C3). Therefore, values for the two modules are zero and not included in the tables.

4.2 Life Cycle Inventory Results

Table 16. Resource Use

PARAMETER	UNIT	6.5 (0.55) HPC WITH CORK UNDERLAYMENT
RPR_E: Renewable primary resources used as energy carrier (fuel)	[MJ]	4.81E+01
RPR_M: Renewable primary resources with energy content used as material	[MJ]	0.00E+00
$NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel)	[MJ]	5.42E+02
$NRPR_M$: Non-renewable primary resources with energy content used as material	[MJ]	0.00E+00
SM: Secondary materials	[kg]	0.00E+00
RSF: Renewable secondary fuels	[MJ]	0.00E+00
NRSF: Non-renewable secondary fuels	[MJ]	0.00E+00
RE: Recovered energy	[MJ]	0.00E+00
FW: Use of net fresh water resources	[m^3]	5.15E-03

Table 17. Output Flows and Waste Categories

PARAMETER	UNIT	6.5 (0.55) HPC WITH CORK UNDERLAYMENT
HWD : Hazardous waste disposed	[kg]	2.61E-03
NHWD: Non-hazardous waste disposed	[kg]	2.82E-03
HLRW: High-level radioactive waste, conditioned, to final repository	[kg]	0.00E+00
ILLRW: Intermediate- and low-level radioactive waste, conditioned, to final repository	[kg]	0.00E+00
CRU: Components for re-use	[kg]	0.00E+00
MR: Materials for recycling	[kg]	0.00E+00
MER: Materials for energy recovery	[kg]	0.00E+00
EE: Recovered energy exported from the product system	[MJ]	0.00E+00

Table 18. Carbon Emissions and Removals

PARAMETER	UNITS	6.5 (0.55) HPC WITH CORK UNDERLAYMENT
BCRP	[kg CO_2]	4.20E-01
BCEP	[kg CO_2]	4.20E-01
BCRK	[kg CO_2]	8.51E-01
BCEK	[kg CO_2]	2.83E-01
BCEW	[kg CO_2]	N/A
CCE	[kg CO_2]	N/A
CCR	[kg CO_2]	N/A
CWNR	[kg CO_2]	N/A

5. LCA Interpretation

Analysis of impact categories on various life cycle stages reveals that the production, transportation (oceanic and road), maintenance, and end-of-life treatment of HPC are the main contributors to its environment impacts. The process contribution analysis reveals that PVC raw materials, electricity consumption, transportation, incineration, and the landfill components of waste treatment contribute the most to the environmental impacts.

The sensitivity analysis shows a change in assumptions (such as transportation distance), inputs during maintenance, the disposal scenarios, and the quality of data can lead to fluctuations in the final LCA results. It is therefore recommended to revise the model with updated data, assumptions, or parameters as they become available to get the most up-to-date and accurate results.

The LCA study has been carried out based on available information, including that from regional and global databases and experience, to make the results as accurate, complete and representative as possible.

6. Additional Environmental Information

6.1 Environment and Health During Manufacturing

No substances required to be reported as hazardous, as listed in the "List of Toxic Chemicals Severely Restricted on the Import and Export in China (Circular No. 65 [2005]) and Measures for the Administration of Restricted Use of Hazardous Substances in Electrical and Electronic Products (Circular No. 32 [2016])", are associated with the production of this product.

6.2 Environment and Health During Installation

Instructions should be followed as indicated on the Safety Data Sheets and installation guidelines.

6.3 Extraordinary Effects

Fire

ASTM E648 Critical Radiant Flux: Class I, >0.45 W/cm^2
ASTM E662 Smoke Density: Passes, <450

Water

In daily use, prevent water and moisture from accumulating underneath walk-off mats. Exposure to flooding for long periods may result in damage to the product.

Mechanical Destruction

Performance requires proper installation according to Novalis installation guidelines.

6.4 Further Information

Novalis High Performance Core (HPC) flooring is certified with GREENGUARD Gold, Indoor Advantage™ Gold and FloorScore®. The total VOC emissions of the product are no more than 0.5 mg/m^3 after a test period of 14 days. The product complies with California DPH Section 01350 Version 1.2 for the school classroom, private office, and single-family residence parameters.

7. References

UL ENVIRONMENT

UL Environment General Program Instructions April 2017, version 2.1

Part A: Life Cycle Assessment Calculation Rules and Report Requirements UL Environment (September 2018, version 3.2)

Part B: Flooring EPD Requirements UL 10010-7, v.2.0, 2018

SUSTAINABILITY REPORTING STANDARDS

European Standards. (2013). EN 15804+A1 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.

ISO. (2006). ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines.

ISO. (2009). ISO 14040: Environmental management - Life cycle assessment - principles and frameworks.

ISO. (2011). ISO 14025: Environmental labels and declarations - Type III environmental declarations - principles and procedures.

ISO. (2017). ISO 21930 Sustainability in building construction - Environmental declaration of building products.

8. Contact Information

8.1 EPD Owner

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8.2 LCA and EPD Practitioner

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