ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	Vector Foiltec GmbH; Nowofol Kunststoffprodukte GmbH & Co. KG; Dyneon GmbH
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-DVN-20210122-IBJ2-EN
Issue date	19.07.2021
Valid to	18.07.2026

Texlon®-System

Vector Foiltec GmbH
Nowofol Kunststoffprodukte GmbH & Co. KG
Dyneon GmbH

Institut Bauen und Umwelt e.V.

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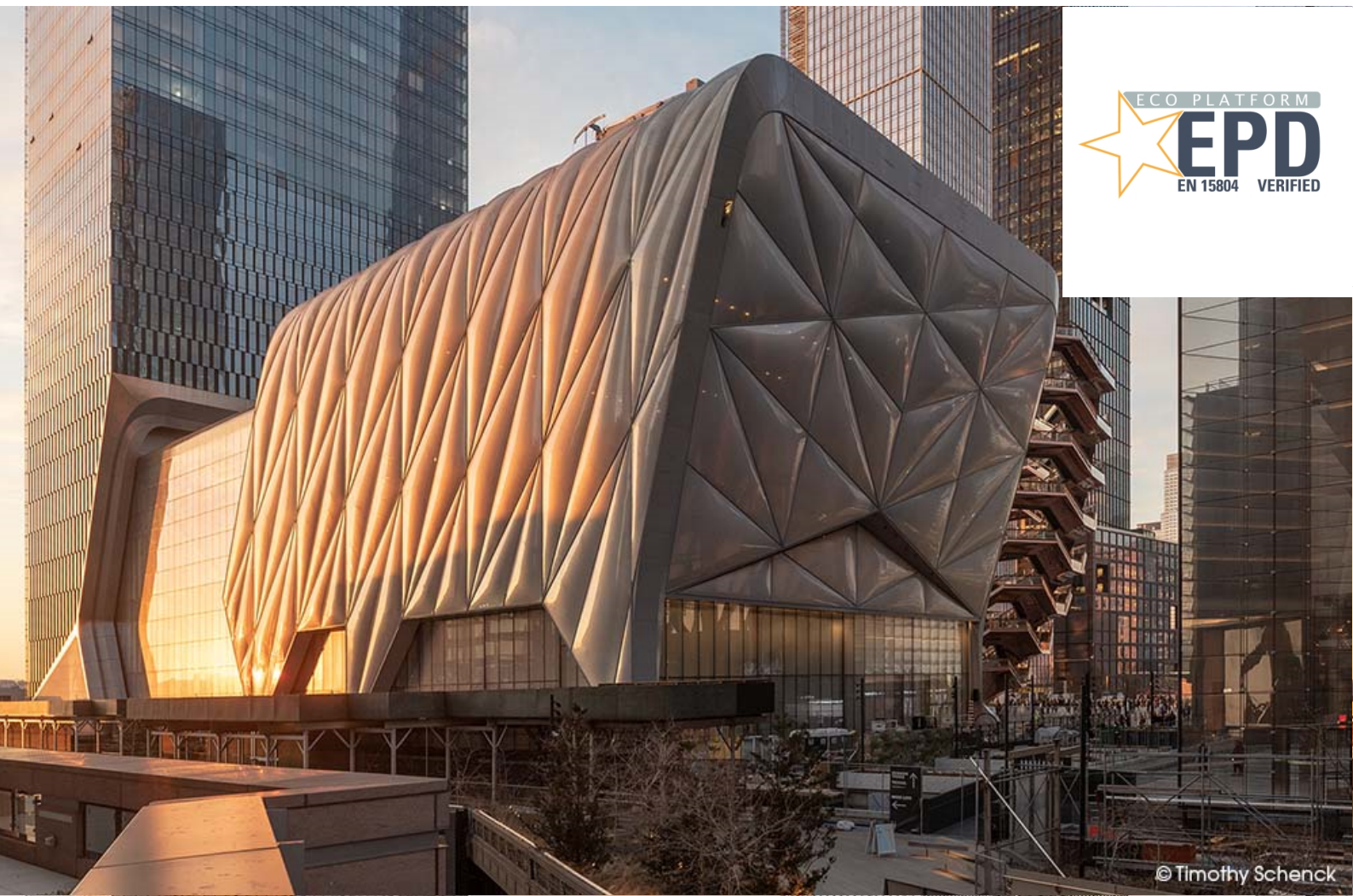

1. General Information

Vector Foiltec GmbH
Nowofol Kunststoffprodukte GmbH & Co. KG
Dyneon GmbH

Texlon®-System

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Declaration number
EPD-DVN-20210122-IBJ2-EN

Declared product / declared unit
1 m² of a standard TEXLON®-System, with a weight per unit area of 3.89 kg/m².

This declaration is based on the product category rules:
ETFE construction element, 04.01.2019
(PCR checked and approved by the SVR)

Scope:
This EPD refers to individual building elements manufactured from ethylene tetrafluoroethylene (ETFE). It is valid for German production facilities. The building elements are manufactured by Vector Foiltec GmbH and traded under the brand trade name Texlon®.
The entire product chain associated with manufacturing the ETFE building elements includes the following companies:
Dyneon GmbH (ETFE granulate)
NOWOFOL Kunststoffprodukte GmbH & Co. KG (ETFE foil)
Vector Foiltec GmbH (ETFE cushions)

Texlon® foil cushions with frames are planned and produced on a project-specific basis. This EPD calculates the life cycle analysis (LCA) for a representative product.

Issue date
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The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.
The EPD was created according to the specifications of *EN 15804+A2*. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard *EN 15804* serves as the core PCR
Independent verification of the declaration and data according to *ISO 14025:2010*
☐ internally ☒ externally

Dipl. Ing. Hans Peters
(chairman of Institut Bauen und Umwelt e.V.)

Dr. Alexander Röder
(Managing Director Institut Bauen und Umwelt e.V.))

Juliane Franze
(Independent verifier)

2. Product

2.1 Product description/Product definition

The Texlon®-System is based on the following principle:
Pneumatically stabilised foil elements are fixed to a sub-structure by means of a high-quality aluminium frame system. Depending on the building physics, the system can consist of between 2 and 5 layers of ETFE foil (ethylene tetrafluoroethylene). The g-values and U-values of the Texlon®-System are determined by the number of layers and also the type of coating used.

According to the structural engineering of the Texlon® system, the ETFE foil thickness varies between 80µm and 350µm.
The individual layers are welded together at the edges and stabilised to approximately 220 Pa (220 N/m²) by means of a low-pressure air system. This EPD is based on a typical 3-layer system with the following build up:

- Inner foil: 200 µm
- Middle foil: 100 µm
- Outer foil: 200 µm

The LCA for a representative product is calculated in this EPD.
The national regulations applicable in the place of use are also applicable to the use of the product. In Germany, for example, the building regulations of the relevant Federal State, and the technical provisions based on these regulations.

2.2 Application

Texlon®-cushions are building elements used for the construction of roofs and façades. The Texlon® system is suitable for new buildings and refurbishment projects.

2.3 Technical Data

This data refers to an ETFE foil with a thickness of 200 µm.

Constructional data

Name	Value	Unit
Melting range in accordance with ASTM D 4591-07	265±10	°C
Grammage in accordance with DIN EN ISO 536	0.35	kg/m²
Tensile strength in accordance with DIN EN ISO 527-1	> 40	N/mm²
Tensile stress at 10% strain in accordance with DIN EN ISO 527-1	> 18	N/mm²
Tensile stress at break in accordance with DIN EN ISO 527-1	> 300	%
Tear Resistance in accordance with DIN 53363	> 300	N/mm
Total energy transmittance in accordance with ISO 15099 (3-Lagen ETFE 200µm/100µm/200µm)	75±5	%
Weld strength in accordance with DIN 527-1	≥ 33	N/mm²
Weathering resistance in accordance with ISO 4892-1 sowie ISO 4892-2 (3-Lagen ETFE 200µm/100µm/200µm)	No changes to mechanical values	-

Performance values of the product in relation to its characteristics pursuant to the relevant technical regulation (no CE marking).

2.4 Delivery status

From an economic and technical perspective, maximum ETFE cushion dimensions of 3.7 metres (width) by 40 metres (length) are recommended. The cushion area should not exceed 120 m².
The large cushions are each folded into a strip which is approx. 30 cm wide and 2.5 m long, and wrapped in a protective film made of polyethylene. The foil package is delivered in a wooden box, with three to six other cushions.
The other components for the whole project (aluminium profiles, piping, seals, screws) are delivered as a complete package.

2.5 Base materials/Ancillary materials

The essential base products are Nowoflon® ET foil, frame material (F16.2 aluminium frame) and sealing materials. The following table shows the mass composition of the average product in 2019.

Composition of Texlon® System

Material	Mass percentage rate
Aluminium frame	64.9 %
ETFE foil	23.1 %
Silicone gasket	11.4 %
PP (piping) ropes	0.5 %
ETFE valves	0.05 %

Nowoflon®-ET-foil: Nowoflon® ET foil is a flexible and strong fluorinated copolymer foil. These foils are transparent over the entire solar range. They can be transparent, printed or dyed.

ETFE valves: These valves are small parts made of the same base material as the foil (ETFE), but they are not transparent and display a lower purity level (recycled).

Aluminium frame: The aluminium frame comprises an extruded base element, a cap and a channel rail.

Polypropylene (piping) ropes: The cord edge welding comprises flexible polypropylene (piping) ropes with a diameter of 6 mm to 8 mm.

Silicone seals: Silicone seals are made of a waterproof rubber-like silicone material.

1) The product contains substances which appear on the ECHA list of Substances of Very High Concern (SVHC) (as at 15.04.2021) in a mass proportion exceeding 0.1%: **no.**

2) The product contains additional CMR substances from category 1A or 1B, which are not on the candidate list, the mass proportion of which exceeds 0.1% in at least one part of the product: **no.**

3) Biocidal products have been added to this construction product, or it has been treated with biocidal products (and is therefore a treated product within the meaning of the Biocidal Products Regulation (BPR, Regulation (EU) 528/2012)): **no.**

2.6 Manufacture

Manufacture of ETFE granulate:
Raw materials and monomers: Mineral fluorspar and natural gas are used to manufacture R22 (chlorine-di-fluoromethane), which is delivered by special road tankers. This is used to manufacture the perfluorinated monomers, such as tetrafluoroethylene (TFE), hexafluoropropylene (HFP) and perfluoro (propyl vinyl ether). These are in turn freed of ancillary products by means of distillation.

Polymerisation: These monomers, together with ethene, are converted to a thermoplastic dispersion by

means of emulsion polymerisation. Non-converted monomers and polymerisation auxiliaries such as emulsifiers are returned to the monomer plant after distillation and re-used.

Recycling (Reprocessing): The degassed thermoplastic dispersion is precipitated and the ensuing powder is dried. The low pourability of this powder means that it is difficult to process, and so it is melted to granulate prior to shipping. The granulate is subjected to quality control to determine whether the product complies with customer requirements.

Production of Nowoflon® ET foils:
ETFE foils are manufactured by cast film extrusion, whereby the granulate is fed into the extruder via a funnel. The granulate is melted in the extruder where it is also homogenised.
A downstream extrusion tool, known as a fishtail nozzle, extrudes the melted plastic onto a chill roller from which it is peeled off. The next stage involves an in-line inspection of the foil thickness and trimming of the foil edges. These trimmings are immediately ground down and redirected to the extrusion process by means of the funnel. The last step of the foil extrusion process involves winding the foil onto a cardboard roll.

Foil waste that cannot be directly recycled passes through a second stage on a regeneration machine before being processed into foil. The application of the recycled material is always subject to a so-called “down-cycling” process.

Fabrication of the foil cushions:
The foil rolls are produced in 1550 mm (width) and – depending on the foil thickness – a length of approximately 200 metres. The individual cushion sections are cut to size on a cutting plotter. The positions of other components, such as valves, are also drawn.

In order to create larger areas the individual sheets are welded together (area welding) and subsequently the valves are installed.

The welded foil sheets are placed on top of each other in two or more layers and welded in place by means of a hand-held welding tongs. Edge welding involves a polypropylene (piping) rope being welded along the edges of the cushions in order to seal the cushions (edge welding).

2.7 Environment and health during manufacturing

The appropriate measures are taken in accordance with the current state of the art.

The Texlon® quality management system was created for the purpose of internal monitoring. It is based on *ISO 9001* and the provisions for admission or approval in individual cases.

In addition, Nowofol's energy management is *ISO 50001* certified.

Within the framework of the Occupational Health and Risk Management System (OHRIS), Dyneon is certified under register number 09-00015 (*OHRIS 2009*)).

2.8 Product processing/Installation

The Texlon® System is installed on the basis of the procedural instructions for the installation of Texlon® Systems, and includes the following work steps:

- The client or their construction management team approves the construction site for the installation
- Pre-installation of seals, hammer head screws, safety nets and profiles on the site, in coordination with the steel construction company responsible for the primary structure
- Creation of safe access to work stations (mobile lifting platforms, safety nets and lines for access, etc.)
- Inspection of the primary structure and elevations for dimensional accuracy. Reporting to the project management team
- Installation of base profiles and stretch strips
- Checking for dimensional accuracy and quality
- Installation of the air supply system
- Installation of Texlon® ETFE panels, with the help of special pulling devices (pullers), to apply the necessary pre-tension
- Final assembly of the profile caps and the Man Safe Systems
- Handover of the test certificates and acceptance by the client
- Site clearance

Before installing the roof surfaces, a risk assessment must be carried out in accordance with Section 5 of the Occupational Safety and Health Act (ArbSchG)

2.9 Packaging

The foil cushions which have been folded for transport are wrapped in polyethylene foil for protection. The individual foil packs are put into wooden boxes of 4-6 foil packs, depending on the size of the cushions. The remaining components are delivered to the construction site either in Euro pallets or in wooden boxes.

2.10 Condition of use

No significant changes in the product characteristics are expected during its design life. To compensate for deviations in cushion pressure caused by changing external conditions (temperature, wind pressure loads/wind suction loads), the cushions are continuously supplied by one or more inflation units. The size of the roof determines the number of inflation units required. The units are controlled by a pressure sensor, and the internal pressure is maintained within a range of between 180 Pa and 250 Pa. An average output of 60 W is required for a roof area of 1000 m².

If required, an air drier can be used in certain air/humidity conditions.

2.11 Environment and health during use

In accordance with the evidence outlined in section 7,

the emissions to air during the use phase fall below of the limit values as per the AgBB scheme.

2.12 Reference service life

When a maintenance contract is concluded, the guaranteed service life is usually 5 years. An average useful life cannot yet be specified, as the first building envelopes made with Texlon® ETFE foils over 35 years ago are still in unrestricted use.

2.13 Extraordinary effects

Fire

Reaction to fire

In accordance with *EN 13501-1,* Nowoflon® ET foil is specified as a B-s1-d0 material as follows:

Fire protection

Name	Value
Building material class	B
Burning droplets	d0
Smoke gas development	s1
FIGRA transparent	0 kW/s
FIGRA printed	0 kW/s
SMOGRA transparent	14,8 m²/s²
SMOGRA printed	26,4 m²/s²

The reaction to fire of the Texlon® System as a building envelope is determined by the so-called "Small Room Test" in accordance with *ISO 13784-1*. Both a system structure with a three-layer transparent ETFE film and a system structure with three-layer cushions – the outer film layer of which had a highly reflective print on the inside – were tested. The results are recorded in *RISE Report 9P00808*, produced by the testing institution. Because the calculation of the FIGRA (Fire Growth Rate) and the SMOGRA (Smoke Development Rate) is not part of *ISO 137841*, these properties were calculated separately by RISE (RISE 2019-06-24) pursuant to *ISO 9705-1*. Neither burning droplets, nor fire spread, nor the escape of flames through the door opening were observed. The addition of the ETFE building envelope to the fire was below the detection limit (max. heat release rate – HRR – not detectable without burner). Accordingly, FIGRA must be set to zero. SMOGRA is defined as the quotient of the maximum smoke development over a period of 60 sec., and the time required for this. If this is less than 0.3 m^2/s, the SMOGRA is set to zero. The SMOGRA of the Texlon® System is shown in the table above.

Water

Nowoflon® ET foil is not affected by water. This was confirmed by a leaching test in Norway - *PD/CEN TS 16637*.

Mechanical destruction

The foils and cushions are extremely resistant to exterior pressure and tensile loads owing to their extraordinary elongation properties.
In the case of fire, explosions or even extreme hailstones, the system is extremely fault-tolerant and is resistant to consequential damage. The cushions can, however, be damaged by direct mechanical influences with sharp or pointed items. Destruction of the exterior layer of foil does not lead to system failure. For example if the upper foil of a 3-layer system is damaged, a 2-layer system is retained and the interior chamber remains protected from environmental influences.
Minor damage can be easily repaired using Texlon® tape.

2.14 Re-use phase

As a general rule, the aluminium caps and base profiles of the Texlon® System can be re-used for new buildings and/or refurbishment projects. These components are usually recycled (statistic value for buildings: 85%).
Nowoflon® ET foils and valves – as well as ETFE offcuts – are recycled by external companies and made into valves and other small parts that can be used in new Texlon® cushions.
Recycling is currently only carried out in Europe, but will be extended to other regions in future. Waste is thermally recycled in other countries.

2.15 Disposal

The waste incurred can be allocated to the following waste codes:

17 02 03: Plastic
17 04 02: Aluminium
17 09 04: Mixed construction and demolition waste with the exception of waste covered by 17 09 01, 17 09 02 and 17 09 03.

The packaging materials (wooden crates, PE foil) are thermally recycled. The waste incurred can be allocated to the following waste codes (*AVV 2017*):
15 01 03 Wood
15 01 02 Plastic
Silicone seals are thermally recycled.
Recycling possibilities are currently being examined
Polypropylene is recyclable but is usually thermally recycled.

2.16 Further information

Further information can be found on the Vector Foiltec website, at www.vector-foiltec.com.

3. LCA: Calculation rules

3.1 Declared Unit

The declaration refers to an average TEXLON® System of 1 m² with a weight per unit area of 3.89 kg/m².

Declared unit

Name	Value	Unit
Declared unit	1	m^2
conversion factor [Mass/Declared Unit]	3.89	-

The weight per unit area of an average ETFE foil cushion is 0.88 kg/m².

3.2 System boundary

The declaration type represents a “cradle-to-gate with options”. For the life cycle assessment of an average ETFE component (TEXLON®), not only production, but also installation, energy consumption during use, and disposal are considered. All relevant life cycle phases are therefore represented.

There are two possible scenarios for the disposal of foil cushion waste:

1. Recycling
2. Waste incineration

Waste processing is considered for scenario 1. In both cases, the seal is incinerated while the aluminium frame is recycled.

The life cycle stages are explained in detail below:

- Product stage (**A1 - A3**): including the upstream chain associated with manufacturing of preliminary products, transport thereof to the respective plant, and expenses involved in producing granulate, foil and foil cushions
- Transport to the construction site (**A4**): average distances by HGV or ship
- Installation on the construction site (**A5**): energy for inflating foil cushions as well as disposal of packaging
- Operational energy use (**B6**): energy consumption for maintaining the interior cushion pressure
- De-construction (**C1**): manual dismantling of the system
- Transport to disposal (**C2**)
- Waste processing (**C3**): Scenario 1: processing foil waste; Scenario 2: incineration of foil waste; incineration of seals
- Benefits and loads beyond the system boundaries (**D**): from energy for the treatment of packaging waste (A5) and the silicone seals, recycling of aluminium profiles and expenses associated with their processing (re-melting), as well as the credit for recycling of ETFE as material under scenario 1, and the credit for the thermal recycling of ETFE under scenario 2.

3.3 Estimates and assumptions

Estimates need to be made for the following cases:

- Frame: The manufacturer has provided a certificate for the aluminium frame, which shows a share of approx. 45% of post-consumer secondary material. This value is used for the EPD.
- Recycling ETFE material (scenario 1): The recycled EFTE granulate cannot be used to produce new ETFE foils, but is used to produce valves and flexible connecting hoses that are required for the operation of cushions.

3.4 Cut-off criteria

All data from operational data collation at Vector Foiltec, Nowofol and Dyneon has been taken into consideration, i.e. all base materials used in accordance with the recipe formula. Transport is recorded for all essential preliminary products, transporting the products to the site, and in the End-of-Life scenario. In the LCA, the production waste generated directly during production, as well as the electrical and thermal energy required and the packaging materials, were taken into account.

The machinery, systems and infrastructure required in production, as well as the costs of transporting the packaging materials, were neglected.

This means that material and energy flows with a share of <1% were also taken into account.

3.5 Background data

The GaBi 6 software was used to model the life cycle of the Texlon® ETFE system. The basic data in the GaBi database is applied for energy, transport, auxiliary products and preliminary products.

The headquarters of the respective companies are in Germany, so the LCA is prepared with Germany as the reference country. Transport to construction sites is modelled internationally. The power consumption for installation and utilization phases relates to Europe, and can be adapted for other countries if required.

3.6 Data quality

Overall, the data quality can be rated as very good. The data quality of the foreground data is very good, as current, specific primary data relating the manufacture of ETFE components was collected.

The data quality of the background data is also very good, as current data relating to foils and granulate production was also collected. The background database used has also been updated.

The background data used was last reviewed in 2019.

3.7 Period under review

The data for this Life Cycle Assessment is based on records from 2019 for each of the three companies. The volumes of raw materials, energy, and auxiliary materials used are considered as average annual values for the respective plant.

3.8 Allocation

Aluminium profiles with a post-consumer recycling share of 45% are modelled as scrap input (open-loop recycling) in A1 - A3, based on a certificate provided by the supplier.

In the case of combustion processes (C3), an MVA and the resulting benefits (D) for electrical and thermal energy are determined, taking into account the elementary composition and the heating value.

When recycling the ETFE foils (C3), an adjustment factor of 55% was estimated for the material recycling potential, based on an economic allocation.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account.

The background database used is GaBi CUP 2020.2.

4. LCA: Scenarios and additional technical information

Characteristic product properties
Information on biogenic Carbon
The product itself does not contain any biogenic carbon, only the product packaging (wooden crates): 0.11 kg carbon per square metre.

The following technical information serves as the basis for the declared modules, or can be used to develop specific scenarios in the context of a building assessment if modules are not declared (MND).

Transport to site (A4)
Average distance per mode of transport in relation to global international transport data (2019).

Name	Value	Unit
Transport distance HGV	244	km
Transport Distanz Ship	4842	km

Installation process (A5)

Name	Value	Unit
Electricity consumption per m²	0.00018	kWh

Reference service life
The referenced average service life is 25 years. A lifespan of 50 years is possible.

Name	Value	Unit
Reference service life	25 - 50	a

Betriebliche Energie (B6)

Name	Value	Unit
Electricity consumption pro a*m²	0.274	kWh
Other energy carriers	0	MJ

End of life (C1–C4)
Conservative estimate for transport to EoL: 1,000 km for transport in Europe (material recycling is currently only performed in Europe). Shorter transport distance for thermal recycling.

Name	Value	Unit
Collected separately (total product)	3.89	kg
Recycling aluminium frame	2.395	kg
For thermal recycling of seals	0,422	kg
For recycling szenario 1: Foil cushion	0,875	kg
For thermal recycling szenario 2: Foil cushion	0,875	kg
For recycling small steel parts	0,196	kg
	-	
	-	

Collection and recycling rates were estimated at 100%. Processing losses were taken into account with 5% for aluminium and 2% for ETFE foils.

Reuse, recovery and recycling potential (D), relevant scenario information Module D contains benefits from incineration process involving packaging waste (A5), seals, and foil cushions (scenario 2), as well as benefits from the recycling of aluminium frames, small steel parts and foil cushions (Scenario 1) (C3). A waste incineration plant with an R1 value>0.6 was assumed.

5. LCA: Results

The following includes the results of the indicators of the impact assessment, the use of resources, as well as waste and other output flows relating to a 1 m2 Texlon® System.

Disclaimer:
EP-freshwater: This indicator has been calculated as “kg P eq” as required in the characterization model (EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe; http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml)

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; ND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	ND	ND	MNR	MNR	MNR	X	ND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 m² Texlon®-System

Core Indicator	Unit	A1-A3	A4	A5	B6	C1	C2/1	C2/2	C3/1	C3/2	C4	D/1	D/2
GWP-total	[kg CO_2-Eq.]	3.68E+1	8.55E-1	6.63E-1	1.11E-1	0.00E+0	1.11E-1	5.62E-2	9.30E-1	1.65E+0	0.00E+0	-1.99E+1	-1.26E+1
GWP-fossil	[kg CO_2-Eq.]	3.71E+1	8.51E-1	1.68E-1	1.10E-1	0.00E+0	1.10E-1	5.58E-2	7.05E-1	1.44E+0	0.00E+0	-1.98E+1	-1.25E+1
GWP-biogenic	[kg CO_2-Eq.]	-3.43E-1	4.75E-4	4.95E-1	3.68E-4	0.00E+0	-1.88E-4	-9.53E-5	2.23E-1	2.17E-1	0.00E+0	-6.68E-2	-2.05E-2
GWP-luluc	[kg CO_2-Eq.]	3.23E-2	3.58E-3	1.15E-5	1.60E-4	0.00E+0	8.89E-4	4.52E-4	1.28E-3	8.48E-5	0.00E+0	-1.08E-2	-3.73E-3
ODP	[kg CFC11-Eq.]	2.11E-7	2.10E-16	1.30E-16	2.43E-15	0.00E+0	1.32E-17	6.70E-18	1.54E-14	6.92E-16	0.00E+0	-8.51E-8	-8.44E-15
AP	[mol H^+-Eq.]	1.15E-1	8.04E-3	1.17E-4	2.43E-4	0.00E+0	3.53E-4	1.79E-4	9.89E-4	4.42E-4	0.00E+0	-7.40E-2	-5.71E-2
EP-freshwater	[kg PO_4-Eq.]	8.65E-5	1.86E-6	1.95E-8	2.95E-7	0.00E+0	3.34E-7	1.70E-7	4.86E-6	1.34E-7	0.00E+0	-2.86E-5	-4.78E-6
EP-marine	[kg N-Eq.]	1.92E-2	4.05E-3	2.97E-5	5.41E-5	0.00E+0	1.59E-4	8.07E-5	3.31E-4	1.52E-4	0.00E+0	-1.01E-2	-7.30E-3
EP-terrestrial	[mol N-Eq.]	2.08E-1	4.46E-2	5.54E-4	5.68E-4	0.00E+0	1.78E-3	9.03E-4	3.53E-3	2.04E-3	0.00E+0	-1.10E-1	-7.95E-2
POCP	[kg NMVOC-Eq.]	6.00E-2	1.18E-2	7.82E-5	1.48E-4	0.00E+0	3.12E-4	1.58E-4	8.10E-4	4.12E-4	0.00E+0	-3.15E-2	-2.32E-2
ADPE	[kg Sb-Eq.]	1.71E-3	7.10E-8	1.85E-9	3.19E-8	0.00E+0	7.87E-9	4.00E-9	1.90E-7	1.01E-8	0.00E+0	-6.60E-4	-1.22E-6
ADPF	[MJ]	4.76E+2	1.14E+1	1.45E-1	1.94E+0	0.00E+0	1.46E+0	7.43E-1	6.46E+0	8.42E-1	0.00E+0	-2.36E+2	-1.50E+2
WDP	[m^3 world-Eq deprived]	2.81E+0	3.68E-3	6.61E-2	2.40E-2	0.00E+0	9.81E-4	4.99E-4	8.05E-2	2.18E-1	0.00E+0	-1.78E+0	-1.58E+0

Caption	GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 m² Texlon®-System

Indicator	Unit	A1-A3	A4	A5	B6	C1	C2/1	C2/2	C3/1	C3/2	C4	D/1	D/2
PERE	[MJ]	1.51E+2	6.61E-1	3.34E+0	8.59E-1	0.00E+0	8.22E-2	4.17E-2	3.61E+0	1.96E-1	0.00E+0	-7.72E+1	-5.93E+1
PERM	[MJ]	3.31E+0	0.00E+0	-3.31E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	[MJ]	1.55E+2	6.61E-1	3.08E-2	8.59E-1	0.00E+0	8.22E-2	4.17E-2	3.61E+0	1.96E-1	0.00E+0	-7.72E+1	-5.93E+1
PENRE	[MJ]	4.55E+2	1.14E+1	2.19E+0	1.94E+0	0.00E+0	1.46E+0	7.43E-1	2.53E+1	1.97E+1	0.00E+0	-2.55E+2	-1.50E+2
PENRM	[MJ]	2.07E+1	0.00E+0	-2.04E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-1.89E+1	-1.89E+1	0.00E+0	1.89E+1	0.00E+0
PENRT	[MJ]	4.76E+2	1.14E+1	1.45E-1	1.94E+0	0.00E+0	1.46E+0	7.43E-1	6.46E+0	8.42E-1	0.00E+0	-2.36E+2	-1.50E+2
SM	[kg]	1.08E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.31E-2	3.31E-2
RSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	[m^3]	2.89E-1	5.92E-4	1.55E-3	9.94E-4	0.00E+0	9.51E-5	4.83E-5	3.59E-3	5.18E-3	0.00E+0	-1.90E-1	-1.54E-1

Caption	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 m² Texlon®-System

Indicator	Unit	A1-A3	A4	A5	B6	C1	C2/1	C2/2	C3/1	C3/2	C4	D/1	D/2
HWD	[kg]	7.46E-7	4.24E-7	1.16E-10	8.03E-10	0.00E+0	6.81E-8	3.46E-8	5.68E-9	3.68E-8	0.00E+0	-1.66E-7	-6.71E-8
NHWD	[kg]	4.27E+0	1.99E-3	4.07E-3	1.38E-3	0.00E+0	2.24E-4	1.14E-4	7.22E-2	3.36E-1	0.00E+0	-2.94E+0	-2.86E+0
RWD	[kg]	2.08E-2	1.20E-5	4.58E-6	2.94E-4	0.00E+0	1.81E-6	9.20E-7	5.30E-4	4.31E-5	0.00E+0	-1.05E-2	-8.19E-3
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.40E+0	3.40E+0	8.58E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	0.00E+0	9.01E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.55E-1	2.30E+0	0.00E+0	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	0.00E+0	2.10E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.25E+0	4.38E+0	0.00E+0	0.00E+0	0.00E+0

Caption	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 m² Texlon®-System

Indicator	Unit	A1-A3	A4	A5	B6	C1	C2/1	C2/2	C3/1	C3/2	C4	D/1	D/2
PM	[Disease Incidence]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
IR	[kBq U235-Eq.]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ETP-fw	[CTUe]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-c	[CTUh]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HTP-nc	[CTUh]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SQP	[-]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Caption	PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

The results of the optional environmental impact indicators are not declared because the uncertainty of these results is high, or because there is only limited experience with the indicator.

Note: The results of module B6 reflect the product use of one year. When applying the results for a building LCA, they must be adapted to the total life span of the building.

Disclaimer 2 – for the indicators ADPE, ADPF, WDP, ETP-fw, HTP-c, HTP-nc, SQP: The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

6. LCA: Interpretation

The majority of environmental impacts and the use of primary energy are caused by the upstream chain, i.e. manufacture of the preliminary products.

Particularly, manufacturing of the aluminium frame which contributes most to the overall system mass is clearly apparent during the production phase.
But also the foil cushion contributes significantly to the environmental impacts. This is particularly attributable to the production of granulate.
Production at Vector Foiltec has barely any effect on the impact categories under review (up to max. 6% of the overall production phase). The other impact categories essentially follow this breakdown for the entire production phase too.

Transport to the construction site is modelled in accordance to the international distribution of the Texlon® System and is based on average data from 2019. Transport can also be significantly less intensive for specific projects.

Neither the energy required for initial inflation of the foil cushion (Module A5) nor for maintaining the internal cushion pressure during the use phase (Module B6) contribute significantly to the overall life cycle in any of the impact categories. It must be noted that the use phase is only modelled for one year, and that this must be adapted to the intended life time of the building.

Two scenarios are presented for the End of Life:
1. Foil cushion material recycling
2. Thermal recycling of foil cushions

In both cases, the aluminium frame and small steel parts are recycled. In both scenarios, there is recovery potential, which is greater in the case of material recycling.

The environmental results were calculated for an average product made in 2019, with a weight per unit area of 3.89 kg per square metre. The weight per unit area is largely determined by the weight of the aluminium frame. In the case of systems with a higher weight per unit area (larger aluminium frame), a higher environmental impact can be assumed, and correspondingly lower environmental impacts with a lower weight per unit area (smaller aluminium frame). This means that larger cushion sizes and spans reduce the environmental impact due to a lower weight proportion of aluminium in the system.

7. Requisite evidence

7.1 VOC emissions

The analysis of the Nowoflon® ET-foil for VOC-emissions in accordance with the AgBB test- and assessment scheme (2021) has been carried out in December 2022 by the Bremer Umweltinstitut – Gesellschaft für Schadstoff-analysen und Begutachtung mbH – durchgeführt.

Measurement conditions:

Temperature	23 °C
Area-specific air flow rate	0.36 m³/(m²h)
Product loading	1.33 m²/m³
Sample surface area	0.33 m²

AgBB Result review (28 days)

Name	Value	Unit
TVOC (C6 – C16)	< 5	µg/m³
Sum SVOC (C16 – C22)	n.d.	µg/m³
R (dimensionsless)	0.000	-
VOC without NIK	n.d.	µg/m³
Cancerogenes	n.d.	µg/m³

detection limit 1 µg/m³ n.d.: not detected

7.2 Release of water-soluble substances

The review of the Nowoflon® ET-foil for the release of water-soluble hazardous substances has been carried out in December 2015 within the framework of the general building permit for Norway by SINTEF Norway in accordance with PD/CEN/TS 16637. Neither the loss of sample mass nor the release of organic components could be determined.

8. References

PCR Part A
Product category rules for building-related products and services from the programme for environmental product declarations of Institut Bauen und Umwelt e.V. (IBU), Part A: Calculation rules for the life cycle assessment and requirements for the project report. Version 1.8, 07/2019, www.ibu-epd.com

PCR: ETFE building elements
PCR guideline texts for building-related products and services Part B: EPD requirements for ETFE components, 2012; www.ibu-epd.com. Institut Bauen und Umwelt e.V. (ed.), Version 1.6, 2017.

EN 15804
EN 15804:2012+A2 2020, Sustainability of construction works – Environmental Product Declarations – Core rules for the product category of construction products

IBU 2019
Institut Bauen und Umwelt e.V.: General program guide for the EPD range of Institut Bauen und Umwelt e.V. (IBU). Version 1.8, Berlin: Institut Bauen und Umwelt e.V., 2019. http://www.ibuepd.com

ISO 14025
DIN EN ISO 14025:201110, Environmental labels and declarations – Type III environmental declarations – Principles and procedures

GaBi ts
Software & Documentation
Sphera Solutions GmbH; GaBi Software-System and Database for Life Cycle Engineering. Stuttgart, Leinfelden-Echterdingen, 1992--2020. Documentation of GaBi data sets: http://documentation.gabi--software.com/

ISO 9001
DIN EN ISO 9001:2008-12, Quality management systems – requirements.

EN 13501-1
EN 13501-1: 2012-1, Fire classification of construction products and building elements – Part 1: Classification using data from reaction to construction product fire tests.

ISO 13784-1
ISO 13784-1:2014-02, Reaction to fire test for sandwich panel building systems – Part1: Small room test.

RISE-Report 9P00808
Reaction to fire test for sandwich panel building systems - part 1: Small room test according to 13784-1 on pneumatically stabilised foil elements, called "Texlon ETFE system", RISE Research Institutes of Sweden AB, Boras, Sweden, 2019

ISO 9705-1:
ISO 9705-1: 2016, Reaction to fire tests - Room corner test for wall and ceiling lining products - Part1: Test method for a small room configuration

RISE 2019-06-24
Calculation of FIGRA and SMOGRA, RISE Research Institutes of Sweden AB, Boras, Sweden, 2019

BRUMI L6921FM
Emission tests of ETFE foils for VVOC, VOC, and SVOC according to AgBB/DIBt requirements for building materials, Bremer Umweltinstitut, Bremen, Germany, 2022

AgBB 2021
Evaluation scheme for VOC emissions from construction products from construction products, Committee for health-related evaluation of construction products, Dessau-Rosslau, Germany, June 2021

ArbSchG §5
Section 5 of the German Occupational Safety Act, Assessment of working conditions, in: Law on implementing occupational safety measures for

improving the safety and health protection of employees in the workplace

AVV 2017
Directive on the European List of Waste Materials, in: Waste List Regulations dated 10 December 2001 (BGBl. I, p. 3379), last amended by Article 2 V. 17.7.2017 I 2644Registration, Evaluation, Authorization and Restriction of Chemicals, 2007

Acerboni et al. 2001
Acerboni G., Beukes J.A., Jensen N.R., Hjort J., Myrhe G., Nielsen C.J., Sundet J.K. (2001), Atmospheric degradation and global warming potentials of three perfluoralkenes. Atmospheric Environment (34), 4113--4123

REACH
Registration, Evaluation, Authorization and Restriction of Chemical Hazards, 2007

EN ISO 527-1
EN ISO 527-1: 2012, Plastics – Determination of tensile properties – Part 1: General principles

ISO-2286-2
ISO-2286-2(1998), Rubber or plastics coated fabrics - Determination of roll characteristics Part 2: Methods for determination of total mass per unit area, mass per unit area of coating and mass per unit area of substrate

DIN 53363
DIN 53363, Testing of plastic films - Tear test using trapezoidal test specimen with incision

ASTM D4591-07(2012)
Standard Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry

ISO 4892-1
ISO 4892-1: 2001-09, Plastics – Artificial irradiation or weathering in devices – Part 1: General guidelines (ISO 4892-1: 1999); German version EN ISO 4892-1: 2001

ISO 4892-2
ISO 4892-2:2013-06, Plastics – Artificial irradiation or weathering in devices – Part 2: Xenon arc lamps (ISO 4892-2:2013); German version EN ISO 4892-2:2013

ISO 15099
ISO 15099:2003, Thermal performance of windows, doors and shading devices - Detailed calculations

OHRIS 2009
Registration office of the State institute for occupational safety and product safety (AP) of the Bavarian State Office for Health and Food Safety (LGL), Munich. www.lgl.bayern.de/arbeitsschutz

TRGS 900
Technical rules for hazardous substances 900, Occupational exposure limit values, edition: January 2006, last amended and supplemented: GMBl 2013 S. 943-947 dated 19.09.2013 [No. 47]

PD/CEN TS 16637
PD/CEN TS 16637-2: 2014, leaching test carried out on Vector Foiltec Texlon® ETFE, by SINTEF Building and Infrastructure, Oslo, Norway, 2015

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