ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

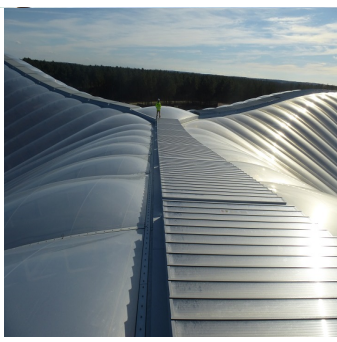
Owner of the Declaration	**Taiyo Europe GmbH**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-TAI-20190092-ICB1-EN
Issue date	05.08.2019
Valid to	04.08.2024

TensoSky® - System with Fluon® ETFE-FILM

Taiyo Europe GmbH, AGC Inc.

Institut Bauen und Umwelt e.V.

www.ibu-epd.com / https://epd-online.com



Taiyo Europe AGC
MakMax

1. General Information

Taiyo Europe GmbH

Programme holder
IBU - Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Declaration number
EPD-TAI-20190092-ICB1-EN

This declaration is based on the product category rules:
ETFE construction element, 07.2014
(PCR checked and approved by the SVR)

Issue date
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Valid to
04.08.2024

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

Dr. Alexander Röder
(Head of Board IBU)

TensoSky®-System
with Fluon®ETFE-Film

Owner of the declaration

Taiyo Europe GmbH
Muehlweg 2
82054 Sauerlach/Germany

Declared product / declared unit

1 m² Taiyo TensoSky®-System (3.93 kg/m² mass per unit area for a 3-layers-system made of FLUON® ETFE-Film (1.05 kg/m² mass per unit area) including all components, like aluminium frame.

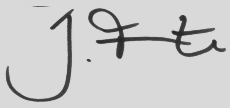
Scope:
This EPD refers to individual construction elements manufactured from ethylenetetrafluoroethylene (ETFE), aluminium and other components. The construction element is used e.g. for building envelopes, cladding roofs, skylights, canopies, curtain walls or facades. It is supplied by Taiyo Europe GmbH, under the brand trade name TensoSky®, here used with Fluon®ETFE-film from AGC Inc, Japan.

The TensoSky®-System is designed, fabricated and packaged for specific projects.This EPD declares the life cycle analysis (LCA) for a specific 3-layers system.

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.

Verification

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



Juliane Franze
(Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

The ETFE construction element with the trade brand name TensoSky® consists of AGC Inc.FLUON®ETFE-film, aluminium and further components with a minor mass proportion. It can be fixed on structural systems, e.g. made of steel, wood or reinforced concrete. The structural system is not included in this EPD. The construction element includes between 1 and 5 ETFE-film layers (ETFE = ethylene tetrafluoroethylene) dependent on building physical, statical or design requirements. The ETFE-film thickness varies between 80µm and 500 µm depending on structural requirements. The individual ETFE-films are welded together, to get a planar or curved single layer or multiple-layers system. This EPD is based on a reference 3-layers system with a film thickness of 250 µm (outer/inner layer) and 100 µm (middle layer). The values for 1-, 2-, 4- and 5-layers systems are derived from this reference project.

For the use and application of the product the respective national provisions at the place of use apply, in Germany for example the building codes of the countries and the corresponding national specifications.

2.2 Application

The TensoSky®-System is a transparent or translucent construction element, used e.g. as cladding roof, skylight, canopy, curtain wall or facade. It is suitable for new buildings and refurbishments. It can be used as a permanent, stationary, moveable, retractable or temporary structure, e.g. for leisure parcs, indoor pools, biospheres, greenhouses, infrastructure buildings, carparks, shopping malls, administration and

educational buildings, hotels, hospitals, museums, public spaces and stadia, but also for pavillons and stands on trade fairs and exhibitions.

2.3 Technical Data

The following technical data indicates the default values for the declared ETFE-film product at the time of delivery. Unless otherwise stated the following material data refer to an ETFE-film with a thickness of 200 µm:

Constructional data ETFE

Name	Value	Unit
Melting range acc. to /ASTM D4591-07/	265±10	°C
Grammage acc. to /DIN EN ISO 2286-2/	0.35	kg/m²
Tensile strength acc. to /DIN EN ISO 527-3/	>50	N/mm²
Tensile stress at 10% strain acc. to /DIN EN ISO 527-3/	>18	N/mm²
Tear Resistance acc. to /DIN 53363/	>400	N/mm
Weld strength acc. to /DIN EN ISO 527-3/	>33	N/mm²
Total energy transmittance acc. to /ISO 15099/	91±5	%
Weathering resistance acc. to /ISO 4892-4/	no optical/mechanical changes	-
Tensile strain at break acc. to /DIN EN ISO 527-3/	>350	%

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).

2.4 Delivery status

The TensoSky®-System is project-specific dimensioned. The single components as ETFE-film elements, aluminum frame etc. are prefabricated separately, packed and delivered to the assembly on construction site. The prefabricated ETFE-film elements are sent to the construction site folded into transportable packages, wrapped in protective polyethylene films and packed in wooden boxes.
For reasons of producability, the assembled ETFE-film elements should not exceed a length of 100 m and a width of 5 m as a rule. The surface of an individual ETFE-film element should not exceed 500 m².

2.5 Base materials / Ancillary materials

Mass Proportions

Name	Value	Unit
Aluminium (frames, air valves)	40	%
ETFE-Film (3 layers)	27	%
Mild Steel (gutter)	22	%
EPDM (gaskets)	5	%
Stainless Steel (fasteners)	3	%
other plastic materials (seals, coating, spacers)	3	%
Total	100	%

The table above shows the mass-proportions of a typical three-layer TensoSky®-System**:**

Aluminium: The system includes frames and an insignificant mass of air valves made of aluminium. The frames consist of a base-profile, a cap-profile and keder-profiles, that hold the ETFE-film elements perimeter edge. The aluminium frame is anodized in the thickness class according to /DIN 17611/, specified for the certain application and utilization.

ETFE-Film: The ETFE-film is a flexible and strong fluorinated co-polymer (ethylene-tetrafluoroethylene). The transparent film is permeable for the entire solar range of irradiation. It can be clear, printed or dyed.

Mild Steel: The system includes an optional gutter made of customary sheets of coated mild steel.

Stainless Steel: Fasteners (screws, bolts, nuts, washers) used are made of stainless steel (min. A2-50) depending on the specified strength and corrosion class.

EPDM: To hold the ETFE-film elements in the aluminum frame, an EPDM-rope (diameter approx. 5-8 mm) is used. Additionall gaskets made of EPDM are inserted in the aluminium frames.

Other plastic materials: The system includes a small mass-proportion of other plastic materials used as seal (aluminium joints), coatings (gutter), gaskets (fasteners) and plastic-spacers (to fix keder-profiles in base-profiles).
Information that product does not contain substances listed in the Candidate List of substances of very high concern /REACH/ exceeding 0.1%: This product contains substances listed in the candidate list (date:15.01.2019) exceeding 0.1 percentage by mass: **no**
This product contains other CMR substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: **no**
Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): **no**

2.6 Manufacture

In the production facilities the individual ETFE-film sections are cut from the roll on a plotter table according to the project-specific cutting patterns. In order to create the ETFE-film elements, the individual ETFE-film sections are welded together in form of a continues seam. Subsequently the air valves are installed in the ETFE-film layers. In case of multiple layers ETFE-film elements the different layers are placed on each other and welded together circumferential of the element's edges. Along the ETFE-film elements perimeter, the edges are formed as a pocket, in which the keder rope is pulled in. The specific 3-layers system the life cycle analysis (LCA) is based on, was manufactured in Bytom/Poland. It is one of more production facilities used by Taiyo Europe. Further are located, e.g. in Bari, Italy, and Edersleben, Germany.

2.7 Environment and health during manufacturing

When manufacturing the TensoSky®-System, relevant standards and generally accepted rules of technology are complied with (e.g. /ArbSchG/, /BRUMI K5437 FM/).The owner of the EPD is certified according to

/DIN EN ISO 14011/. AGC Inc. as the manufacturer of the ETFE-resin and the extruded ETFE-film is also certified.

2.8 Product processing/Installation

The prefabricated ETFE-film elements are unfolded at the construction site and pulled, along their edge, into the aluminum clamping profiles. Subsequently, an aluminum cover profile is screwed onto the aluminum base profile, which seals the system together with EPDM seals against driving rain. In the case of multi-layered ETFE-film elements, the air supply lines are then connected and the air is blown into the chambers between the ETFE-film layers to stabilize the ETFE-film elements. For the installation of the ETFE-film elements on building site only usual tools and safety equipment related to the respective kind of works are necessary, but no machines. The works generate no extraordinary emissions, in particular noise, gasses or dust.

2.9 Packaging

The packaging consits of wooden boxes/crates, protective polyethylene films and carboards. All materials are typically thermally recycled.The waste incurred can be allocated to the following waste codes according to /AVV 2017/:

15 01 01: paper and cardboard packaging
15 01 02: plastic packaging
15 01 03: wood packaging

2.10 Condition of use

No significant changes in the product characteristics are expected during its design life. To compensate deviations in the overpressure between multiple layers ETFE-film systems caused by changing external conditions (e.g. wind and snow loads), the enclosed air volumes between the layers are continuously supplied by air blower units. The size of the roof and the intended air exchange rate determine the number and dimension of the units required. The units are controlled by a pressure sensor and internal pressure is maintained within a range between approximately 200 Pa and 1000 Pa by means of a low-pressure air inflation system. To reduce the humidity of the inflated air and to avoid condensation in multiple layers ETFE-film elements dehumidifier with a defined air exchange rate may be used.

2.11 Environment and health during use

In accordance with the evidence outlined in section 7, emissions to ambient air during the use phase are below the threshold values set by the /AgBB/ evaluation scheme.

2.12 Reference service life

The reference service life is ensured for about 25 years on average. Up to 50 years are possible. A calculation according to /ISO 15686/ is not applied.

2.13 Extraordinary effects

Fire

According to /EN13501–1/ the ETFE-film product FLUON® is classified as follows:

Name	Value
Building material class	B
Burning droplets	d0
Smoke gas development	s1

Water

Tests according to /ASTM D570/ are showing, that ETFE-film is not affected by water. The water absorption is evaluated to 0.03% according to /AGC FLUON® ETFE-film/.

Mechanical destruction

The TensoSky®-System is extremely resistant to tensile loads owing to the ETFE-films extraordinary elongation properties. In the case of fire, explosions or earthquakes, the system is extremely fault-tolerant and has a low risk of consequential damage. The ETFE-film can, however, be damaged by direct mechanical influences (e.g. by vandalism) with sharp or pointed objects. In case of a multiple layers ETFE-film system the destruction of the exterior layer does not lead to system failure automatically and water leakage into the interior of the building. Minor damages can be easily repaired using TensoSky® ETFE-tape with an adhesive layer on its back side. It can be applied for single-layer and multiple layers TensoSky®-Systems.

2.14 Re-use phase

As a general rule, the frame and the valves made of aluminium can be re-used for new buildings and/or refurbishment of projects. Where the application of this rule is impossible, the aluminium returns to the manufacturers. The aluminium used for the TensoSky®-System consists of 41% secondary aluminium on average.

2.15 Disposal

Components made of steel are processed as metallic scrap. Although the clear ETFE-film used is returned into the material cycle after it has been removed, the film is no longer used for architectural applications, but rather for ETFE components with lower requirements, such as electric isolators. Printed ETFE-films, EPDM materials and other materials with a very low mass fraction used can be thermally recovered. The waste after at the end of the products life can be allocated to the following waste codes according to /AVV/:

17 04 02: aluminium
17 02 03: plastic
17 09 04: mixed construction and demolition waste (excepted waste covered by 17 09 01 - 17 09 03)

2.16 Further information

Additional information is available on the Taiyo Europe webpage (www.taiyo-europe.com).

3. LCA: Calculation rules

3.1 Declared Unit

The declaration refers to 1 m² of the TensoSky®-System (3.93 kg/m² mass per unit area for all components) including 3 layers of FLUON® ETFE-film (1.05 kg/m² mass per unit area).

Declared unit

Name	Value	Unit
Declared unit	1	m^2
Conversion factor to 1 kg	0.2545	-

To provide results for projects with 1- layer, 2-layers, 4-layers and 5-layers of FLUON® ETFE-film the EPD Annex contains the different layer scenarios:

Mass Proportions

Szenarios (number of layers) / Materials	1 layer	2 layers	3 layers	4 layers	5 layers
Aluminium (frames, air valves)	47%	42%	**40%**	38%	36%
ETFE-Film	13%	23%	**27%**	30%	33%
Mild Steel (gutter)	26%	23%	**22%**	21%	20%
EPDM (gaskets, seals, keders)	7%	6%	**5%**	5%	5%
Stainless Steel (fasteners)	4%	3%	**3%**	3%	3%
Other plastic materials (coatings, spacers)	3%	3%	**3%**	3%	3%
Complete System	100%	100%	100%	100%	100%
Weight [kg/m²]	**3,32**	**2,76**	**3,93**	**4,11**	**4,28**

3.2 System boundary

The EPD of the ETFE construction element, includes the production as well as installation, use phase and the End of Life of the product. The following life cycle phases are considered:

Production

A1-A3 – Raw material supply, production of pre-products (ETFE-film, aluminium frame, further parts) and manufacturing. Transports of raw materials (ETFE-film, aluminium…) and components/ pre-products are included in A2

Installation

A4 – Transport to building site
A5 – Initial installation into building (including packaging waste processing, energy and material for the assembly of the building element and the electricity effort for first inflation)

Use stage

B1 – Use / application: Release of substances to indoor air, soil and water
B2 – Maintenance: Cleaning, yearly check and replacement of worn and damaged parts
B6 – Operational energy use: Maintaining the cushion pressure **for a period of one year**
B7 – Operational water use

End-of-life

C1 – Deconstruction/ demolition (including only minor effort for the deconstruction of the building element)
C2 – Transport to waste processing resp. recycling material processing,
C3 – Waste processing for recovery and recycling (including the incineration of ETFE and plastics and the recycling of aluminum and steel)
C4 – Disposal (landfilling)

3.3 Estimates and assumptions

The content of secondary aluminium in the aluminium frame is 41% as weighted average percentage based on written information of the aluminium supplier.The ETFE construction elements are assembled on the construction site. All transportation distances are included in A2. In A4 no further transports are considered. The electricity consumption for installation (A5) and utilization (B6) is related to Europe as an exemplified reference region. In this study an energy consumption of 0.26 kWh/m²/a is taken into account for the air supply system.

3.4 Cut-off criteria

Packaging waste (like foil, paper) arising during production (A1-A3) is not considered in this study due to negligible amounts (<0.1%). Apart from that all available data from production process are considered. Thus, all material and energy flows contributing less than 1% of mass or energy are considered. Transport processes for packaging materials are neglected. Production of infrastructure required for manufacture are outside the scope of this assessment. The sum of the excluded flows does not exceed 5% of mass, energy or environmental relevance.

3.5 Background data

The /GaBi ts/ software was used to model the life cycle of the ETFE system. The data in the GaBi database version 8.07 is applied for energy, transport, auxiliary products and preliminary products. It had been revised in 2016.

3.6 Data quality

Overall the data quality can be described as good, as the level of completeness is very high and the collected primary data reflect current conditions (reference year 2016). To ensure consistency, all primary data are collected with the same level of detail, while all background data are sourced from the GaBi databases. Allocation and other methodological choices are made consistently throughout the model.

3.7 Period under review

The foreground data collected by the manufacturer for the production process are based on yearly production amounts and extrapolations of measurements on specific machines and plants. The production data refer to an average of the year 2016. The foreground data was collected specifically for one project by the manufacturer for the materials/components used (ETFE, EPDM, aluminium, stainless steel, mild steel and the other plastic materials).

3.8 Allocation

The overall production of Taiyo Europe GmbH comprises further products (other layer systems) beside the product considered in this study; therefore, allocation was applied for the consumption of thermal and electrical energy as well as other auxiliary materials. Allocation factors were defined based on mass.

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.

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4. LCA: Scenarios and additional technical information

The following information is the basis of the declared modules.

Transport to the building site (A4)

Name	Value	Unit
Transport distance	0	km

The assembly of the ETFE construction elements takes place at the construction site. All transports of materials and pre-products (ETFE-film, aluminium frame, further parts) are included in A2. There are no further transportation processes in module A4.

Installation into the building (A5)

Name	Value	Unit
Electricity consumption	0.00096	kWh

Use or application of the installed product (B1) see section 2.11, 2.13 and 7

Maintenance (B2)

Name	Value	Unit
Water consumption	0	m^3
Other resources	0	kg
Electricity consumption	0	kWh

No effort for cleaning and repair to maintain the ETFE construction element is needed. Its surface is considered as self-cleaning by rain and does not require, therefore, any further energy or water. Necessity of cleaning and life span depend on utilization and environmental conditions.

Reference service life

Name	Value	Unit
Life Span (expected, average)	25	a

Operational energy use (B6) and Operational water use (B7)

The values in module B6 **refer to a period of use of one year**. The table below shows the values of the water consumption and the electric energy consumption (depending on the used type of air supply system). The calculations are done for an open system with air flow (not predried, 0.26 kWh per square meter and year):

Name	Value	Unit
Water consumption	0	m^3
Electricity consumption Open system with air flow (predried)	0.84	kWh
Electricity consumption Closed loop system with air flow (predried)	0.76	kWh
Electricity consumption Open system with air flow (not predried)	0.26	kWh
Electricity consumption Closed system without air flow (not predried)	0.06	kWh

End of life (C1-C4)

Name	Value	Unit
Collected separately waste type	4	kg
Recycling	2.6	kg
Energy recovery	1.4	kg

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Module D includes potential benefits from energy substitutions from incineration processes of packaging waste (A5), seals, and the ETFE-film elements (C3) and from recycling the aluminum frames. A waste incineration plant with an R1 value of > 0.6 is assumed.

5. LCA: Results

The following table depicts the results concerning the estimated impact, use of resources and waste and other output flows in relation to **1 m² of Taiyo Europe's TensoSky®-System** (3.93 kg/m² mass per unit area for a 3 layers-system made of FLUON® ETFE-FILM (1.05 kg/m² mass per unit area) and included aluminium frame). The EPD Annex provides results of other layer scenarios (1-layer, 2-layers, 4-layers and 5-layers) of the specific ETFE construction element. All declared modules are indicated with an "X", the modules B3, B4, B5 are marked as MNR (module not relevant). Environmental impacts were calculated with using characterisation factors of CML 2001, published in April 2013 /CML/.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

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	X	X	MNR	MNR	MNR	X	X	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² Taiyo ETFE construction element

Parameter	Unit	A1-A3	A4	A5	B1	B2	B6	B7	C1	C2	C3	C4	D
GWP	[kg CO_2-Eq.]	5.32E+1	0.00E+0	9.16E-1	0.00E+0	0.00E+0	1.08E-1	0.00E+0	0.00E+0	5.31E-2	2.25E+0	0.00E+0	-9.37E+0
ODP	[kg CFC11-Eq.]	2.67E-4	0.00E+0	1.12E-14	0.00E+0	0.00E+0	4.80E-13	0.00E+0	0.00E+0	1.45E-15	9.99E-14	0.00E+0	4.13E-11
AP	[kg SO_2-Eq.]	1.08E-1	0.00E+0	1.11E-4	0.00E+0	0.00E+0	3.06E-4	0.00E+0	0.00E+0	1.23E-4	2.11E-2	0.00E+0	-3.99E-2
EP	[kg $(PO_4)^{3-}$-Eq.]	8.07E-3	0.00E+0	2.44E-5	0.00E+0	0.00E+0	2.87E-5	0.00E+0	0.00E+0	3.13E-5	6.80E-5	0.00E+0	-2.50E-3
POCP	[kg ethene-Eq.]	9.36E-3	0.00E+0	7.37E-6	0.00E+0	0.00E+0	1.92E-5	0.00E+0	0.00E+0	-4.17E-5	3.02E-5	0.00E+0	-2.43E-3
ADPE	[kg Sb-Eq.]	1.45E-4	0.00E+0	1.30E-8	0.00E+0	0.00E+0	5.73E-8	0.00E+0	0.00E+0	4.34E-9	2.64E-7	0.00E+0	-3.63E-6
ADPF	[MJ]	4.88E+2	0.00E+0	1.98E-1	0.00E+0	0.00E+0	1.15E+0	0.00E+0	0.00E+0	7.20E-1	7.43E-1	0.00E+0	-1.00E+2

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

RESULTS OF THE LCA - RESOURCE USE: 1 m² Taiyo ETFE construction element

Parameter	Unit	A1-A3	A4	A5	B1	B2	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	6.75E+1	0.00E+0	6.06E+0	0.00E+0	0.00E+0	7.41E-1	0.00E+0	0.00E+0	3.98E-2	1.83E-1	0.00E+0	-4.41E+1
PERM	[MJ]	6.02E+0	0.00E+0	-6.02E+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]	7.36E+1	0.00E+0	4.17E-2	0.00E+0	0.00E+0	7.41E-1	0.00E+0	0.00E+0	3.98E-2	1.83E-1	0.00E+0	-4.41E+1
PENRE	[MJ]	4.86E+2	0.00E+0	3.81E-1	0.00E+0	0.00E+0	1.97E+0	0.00E+0	0.00E+0	7.22E-1	2.72E+1	0.00E+0	-1.19E+2
PENRM	[MJ]	2.64E+1	0.00E+0	-1.60E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-2.63E+1	0.00E+0	0.00E+0
PENRT	[MJ]	5.13E+2	0.00E+0	2.21E-1	0.00E+0	0.00E+0	1.97E+0	0.00E+0	0.00E+0	7.22E-1	9.23E-1	0.00E+0	-1.19E+2
SM	[kg]	8.50E-1	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
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	[m³]	2.39E-1	0.00E+0	2.22E-3	0.00E+0	0.00E+0	1.01E-3	0.00E+0	0.00E+0	7.34E-5	6.18E-3	0.00E+0	-1.11E-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 – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² Taiyo ETFE construction element

Parameter	Unit	A1-A3	A4	A5	B1	B2	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	1.87E-3	0.00E+0	1.84E-10	0.00E+0	0.00E+0	9.25E-10	0.00E+0	0.00E+0	4.18E-8	4.51E-8	0.00E+0	2.50E-3
NHWD	[kg]	2.90E+0	0.00E+0	2.20E-3	0.00E+0	0.00E+0	1.39E-3	0.00E+0	0.00E+0	6.05E-5	3.39E-1	0.00E+0	-1.95E+0
RWD	[kg]	1.36E-2	0.00E+0	9.42E-6	0.00E+0	0.00E+0	3.27E-4	0.00E+0	0.00E+0	9.89E-7	7.12E-5	0.00E+0	-7.50E-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	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.35E+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	2.28E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.13E+0	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	0.00E+0	5.26E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.83E+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

Note: The values in module B6 are related to an open system with air flow (not pre-dried). **They refer to a period of use of one year**. When using the values in the building context, they must be scaled to the specific building service life time.

6. LCA: Interpretation

Interpretation of results for the production stage (A1-A3)
The environmental profile of the production of the system is determined by the manufacturing of the components ETFE-film and aluminium frame. The main influence of ETFE-film is to find in categories **GWP, ODP, POCP** and **ADPF**. Within **AP** and **EP** the ETFE-film has relevant influence. The aluminium frame is of relevant influence in **AP, EP** and of some influence in most of the impact categories (**GWP, POCP, ADPF**).
Minor or even negligible influence is given with regard to **ODP** and **ADPE**. The environmental impact of mild steel is significant only in the category **ADPE**.
All other processes and materials are of minor importance and are showing impact shares < 10% with the exception of 17% **ADPE** of the stainless steel fasteners.Transport has only some importance regarding **EP** and little importance regarding **AP**.
The energy consumption (electricity) and packaging are not significant and have negligible influence.

Interpretation of the results within the entire life cycle
The main contributors - valid for **all impact categories** considered - are the preliminary processes (upstream) in A1 to A3, most notably the manufacturing of the ETFE-film and of the aluminum profiles. Neither transport to the site (A2), energy consumption during installation and use (A5 and B6), nor transport to disposal (C2) are of mentionable relevance. The results for the use stage impact B6 is declared with the effort per year in chapter 5. Assuming a service life of 25 years the impact of B6 would increase to 5% to 16% relating to the manufacturing impact (A1-A3).

7. Requisite evidence

7.1 VOC emissions

Inspection of Fluon® ETFE-fIlm for Volatile Organic Compound (VOC) emissions in accordance with the evaluation scheme /AgBB/ was carried out in September 2017 by the Environmental Institute Bremen (Bremer Umweltinstitut - Gesellschaft für Schadstoffanalysen und Begutachtung mbH /BRUMI K5437FM/) in accordance with the principles of the "Deutsches Institut für Bautechnik (DIBt)" for the health assessment of construction products in interiors (DIBt-Grundsätze für die gesundheitliche Bewertung von Bauprodukten). The results of the test are based on the NIK-list from February 2015.

Measurement conditions
Temperature: 23 °C
Area specific air flow rate: 0.36 m³/(m³h)
Loading: 1.4 m²/m³

AgBB overview of results (28 days)

Name	Value	Unit
TVOC (C6 - C16)	18	µg/m³
Sum SVOC (C16 - C22)	< 5	µg/m³
R (dimensionless)	0.016	-
VOC without NIK	< 5	µg/m³
Carcinogenic Substances	< 1	µg/m³

Detection limit: 1 µg/m³

Trichloroethylene, Benzene, DEHP and DBP could not be detected. According to /BRUMI K5437 FM/ the sample fulfilled the requirements of **category A + of the French VOC regulations**.

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Publisher
Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Tel +49 (0)30 3087748- 0
Fax +49 (0)30 3087748- 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

Programme holder
Institut Bauen und Umwelt e.V.
Panoramastr 1
10178 Berlin
Germany

Tel +49 (0)30 - 3087748- 0
Fax +49 (0)30 – 3087748 - 29
Mail info@ibu-epd.com
Web **www.ibu-epd.com**

Author of the Life Cycle Assessment
thinkstep AG
Hauptstraße 111- 113
70771 Leinfelden-Echterdingen
Germany

Tel +49 711 341817-0
Fax +49 711 341817-25
Mail info@thinkstep.com
Web **http://www.thinkstep.com**

Owner of the Declaration
Taiyo Europe GmbH
Mühlweg 2
82054 Sauerlach
Germany

Tel +49 8104 62898-0
Fax +49 8104 62898-99
Mail k.moritz@taiyo-europe.com
Web **https://www.taiyo-europe.com/**