ENVIRONMENTAL PRODUCT DECLARATION

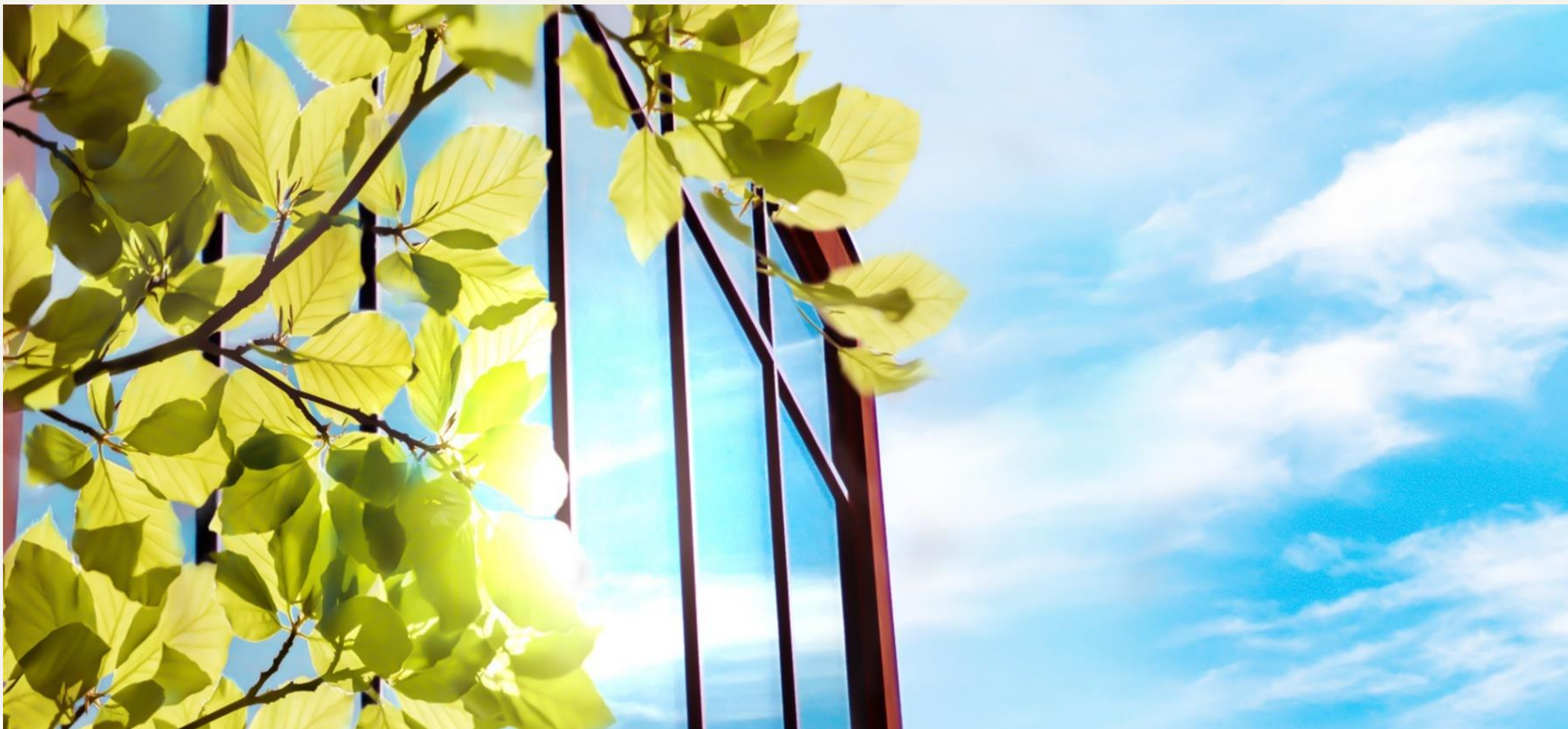
In accordance with ISO 14025 and SS-EN 15804_2012+A1:2013 for:

ConverLight® glass laminate

from

ChromoGenics AB

Programme:	The International EPD® System www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-01475
ECO EPD reference number:	00000798
Publication date:	2018-12-20
Revision date:	2019-02-12
Validity date:	2023-12-19
Geographical scope:	Sweden



1 GENERAL INFORMATION

The EPD owner has the sole ownership, liability, and responsibility for the EPD. EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804.

EPD owner:	ChromoGenics ChromoGenics AB Ullforsgatan 15 SE-75228 Uppsala Sweden Phone: +46 18 430 04 30 Email: info@chromogenics.com
EPD study scope	ConverLight® glass laminate with dynamic solar control features produced by ChromoGenics AB
EPD study base	The EPD is developed in accordance with ISO 14025:2010, PCR 2012.01 Construction products and construction services, version 2.2, EN 15804:2014.
EPD programme operator:	EPD® The International EPD® System EPD International AB Box 210 60 SE-100 31 Stockholm Sweden www.environdec.com
EPD registration number:	S-P-01475
Publication date:	2018-12-20
Validity date:	2023-12-19
Product group classification:	UN CPC 37113 “Float glass and surface ground or polished glass, in sheets.”
Reference year for data:	2017
Geographical scope:	Sweden
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☒ EPD verification	
Third party verifier:	Martin Erlandsson, IVL Swedish Environmental Research Institute
LCA author:	PE Teknik & Arkitektur PROJEKTENGAGEMANG Projektengagemang Energi & Klimatanalys AB Årstaängsvägen 11 100 74 Stockholm www.pe.se Contact person: Pia Stoll, PhD

2 ABOUT THE COMPANY

ChromoGenics offers dynamic glass with controllable heat- and light transmission. The company's unique technology ConverLight® provides sustainable solar control for increased indoor comfort and energy efficiency. ConverLight also contributes to Green Building certifications. In 2016 the company started commercial sales to real estate projects in Scandinavia. ChromoGenics is located in Uppsala, Sweden, and the technology is derived from the world leading research center at Ångström Laboratory at Uppsala University. The plant has been partly financed by a conditional loan from the Swedish Energy Agency. ChromoGenics share (CHRO) is listed on Nasdaq First North Stockholm with G&W Fondkommission as Certified Adviser.

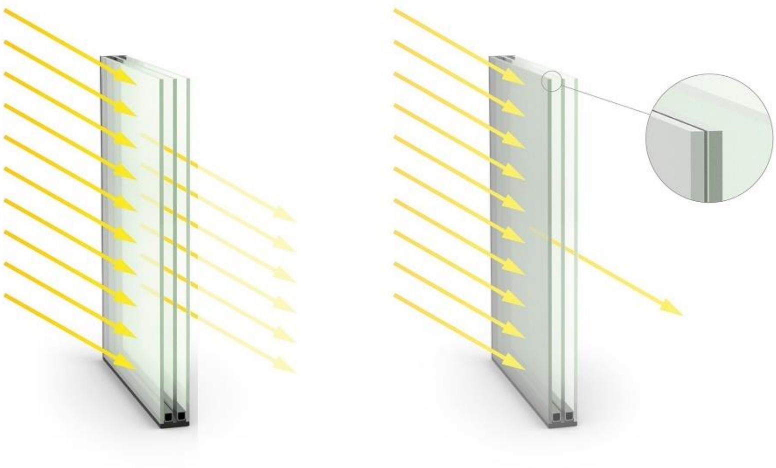
3 PRODUCT INFORMATION

3.1 Product name

The name of the product declared in this EPD is **ConverLight® glass laminate.**

3.2 Product description

ConverLight® glass laminate consists of a ConverLight foil placed between two sheets of tempered float glass. By using a multilayer structure comprising several different materials between two plastic films, a flexible and lightweight ConverLight foil is created. The foil is capable of changing its degree of shading by applying a low electrical voltage. The foil does not use electricity except when the shading is being altered. The ConverLight control unit (CCU), with output power of 1 W, regulates the foil's shading, either manually or automatically, for example, by connecting it to a sensor network. Application areas are numerous, including controlled shading of windows in buildings, aircraft, motor vehicles and boats – wherever optical quality, visual comfort and temperature comfort contribute to safe and efficient operation. ConverLight is adaptable for your needs. It's delivered according to the desired insulating glass (IGU) configuration with the CCU. Each individual CCU can manage up to four windows. The control function is always tailor-made in each case.



3.3 UN CPC code

This EPD refers to the application area "building windows". The product is classified under UN CPC Code 37113 "Float glass and surface ground or polished glass, in sheets."

3.4 Geographical scope

The product's performance has been calculated for the geographical location Stockholm, Sweden, for use and end-of-life.

4 LCA

4.1 Declared unit

The declared unit is one square meter (1 m^2) of ConverLight® glass laminate in the configuration of a ConverLight film laminated in between two layers of 4 mm tempered float glass (equal to 22 kg/m^2).

4.2 Time representativeness

For the manufacture of ConverLight glass laminate, industry data for the core module were collected for the year 2017. The quantity data for the raw materials, energy and ancillary materials used are annual averages.

4.3 System diagram

The product life cycle covered by this EPD is illustrated in the system diagram in Figure 1. The background system processes are modelled using generic data. The product specific processes accounted for are the electrochromic film and the ConverLight glass laminate manufacturing in Uppsala, Sweden.

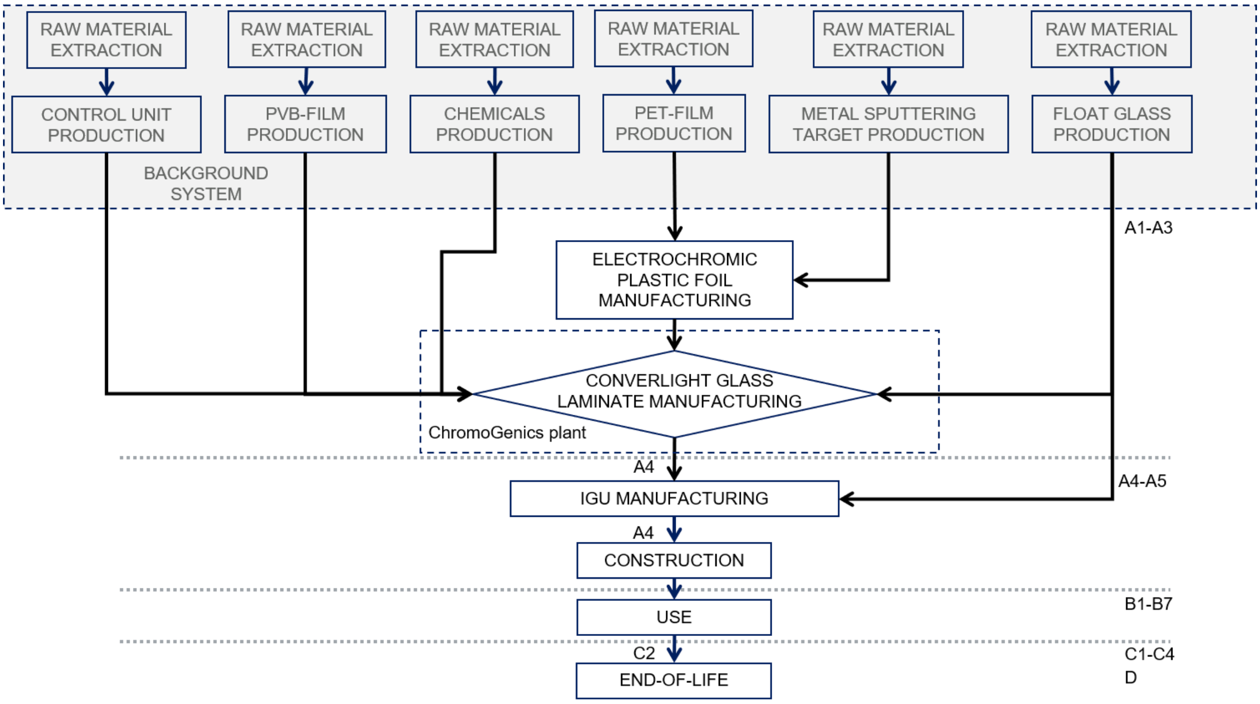


Figure 1 ConverLight glass laminate, Life Cycle Stages

4.4 Cut-off criteria

The data collected from ChromoGenics includes almost 100% of total inflows (mass and energy) to the upstream and core module. The missing data is assumed to constitute less than 5 % of the total inflow.

Infrastructure, construction, production equipment, and tools that are not directly consumed in the production process and personnel-related impacts, such as transportation to and from work, are not accounted for in the LCA.

Data quality and data availability

Background data have been modelled in the openLCA tool v.1.6.3 with generic data from the database:

- GaBi Professional database (updated 2016) imported to and used in the openLCA tool

The LCA has used the Impact assessment method SS-EN 15804:2012 + A1:2013 with the CML (baseline), v.4.4 of January 2015.

Some data was not available and for these the following proxies were used

- Proxy data
  - PVB LCI data was not publicly available or part of GaBi 2016 Professional database. Instead EVA film LCI data was used as a proxy for the PVB-film production as EVA film and PVB film are commonly used for lamination of glass
  - ChromoGenics could not retrieve specific energy consumption for the autoclave's lamination process and instead generic data from the glass industry for energy consumption of glass lamination has been used

The age of the generic data is between 2-7 years old. The product specific data is between 1-4 years old. The data quality requirements in SS-EN 15804:2012+A1:2013 for construction products are met.

Impact assessment

The EPD's impact assessment method is EN 15804:2012.

Allocation

Allocation is performed according to the stepwise procedure in EN 15804 and allocation of by products with low value not applied.

4.5 Life stages declared

The life cycle analysis performed for this EPD includes the stages cradle-to-gate (A1-A3), transport (A4), operational energy use (B6), transport to waste processing (C2) and Benefits and loads beyond the system boundary (D). It permits a "cradle-to-gate with options" EPD. Module A1-A3 is declared as one "cradle-to-gate" module.

Product stage			Construction 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	Construction, Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse/ Recovery/ Recycling potential
x			x	MND	MND	MND	MND	MND	MND	x	MND	MND	x	MND	MND	x

x = included in LCA; MND = module not declared

Product stage, A1-A3

ConverLight® electrochromic film production

The ConverLight electrochromic PET films, Ni-PET and W-PET, are produced at an external custom Roll to Roll metallizer of evaporative, sputtered and dielectric coatings. For the production of the ConverLight electrochromic PET films, metalizing and sputtering roll-to-roll machines are leased for a couple of weeks each year. Sputter coating is a method in which a metal target is bombarded with energetic particles upon which metal atoms are deposited on the PET-film substrate. The amount of metal required for a batch of electrochromic PET-film is very small.

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ConverLight glass laminate manufacturing

At the ChromoGenics production site in Uppsala, Sweden, the ConverLight electrochromic foil is created through a process that produces a multilayer structure comprising an electrolyte between the two electrochromic PET films. The ConverLight electrochromic foil is laminated, using PVB-film, between two tempered float glass panes forming the ConverLight glass laminate solution. The operation of the insulating glass unit containing the ConverLight glass laminate does require the use of a CCU. The environmental impact of the CCU is approximated using data from the EPD “Electronic control units M-EPD-SVR-GB-002”.One CCU can control up to 4 windows. If each window in average has the size of 5 m^2, one CCU controls up to 20 m^2 of ConverLight glass laminate. The environmental impact of one CCU is therefore allocated to 20 declared units of ConverLight glass laminates, i.e. one declared unit of ConverLight glass laminate is allocated 1/20 of the environmental impact of one declared unit of the CCU.

The transport packaging required to transport the ConverLight glass laminate to the IGU manufacturing site is assumed to be incinerated for energy recovery and is reported as such for this stage.

Construction process stage, A4-A5

Transport to the building (A4)

The ConverLight glass laminate is transported by truck to a Swedish IGU manufacturer. The IGU manufacture places the ConverLight glass laminate as the outer glass layer of the IGU. For this EPD, a scenario is used where the IGU manufacturer is located in Vetlanda, Sweden. This is a realistic scenario as there is an IGU manufacturer in this location who can serve the south and middle parts of Sweden. A4 includes the transport from the Uppsala manufacturing site to the building site.

Life Cycle Stage	Cargo	From	To	Distance (km)	How
A4	ConverLight glass laminate	Uppsala, Sweden	Vetlanda, Sweden	420	Truck, Euro 5, 17.3 t max payload
A4	ConverLight glass laminate	Vetlanda, Sweden	Stockholm, Sweden	350	Truck, Euro 5, 17.3 t max payload

Installation in the building (A5)

The IGU is installed as any IGU with the addition of connecting the wiring of the ConverLight glass laminate in the window to the CCU. The thin wiring between the window and the CCU is omitted from this EPD as the specific wiring length varies between installation sites and no average value is known. The sorting of the packaging material is not declared as it’s not contributing to any environmental impacts. Therefore, A5 is not declared in the EPD.

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Use stage, B1-B7

Reference Service Life

If used according to its intended use, the electrochromic function of the ConverLight glass laminate can be expected to have a service life of 20 years. The ConverLight glass laminate still serves as a normal glass in the insulated glass unit after this lifetime but the electrochromic functions cannot be guaranteed, i.e. no additional energy saving as a result of the electrochromic functions is guaranteed after 20 years.

Use of the installed product in terms of emissions, B1

The electrochromic foil is encapsulated between the glass panes in the ConverLight glass laminate and as such does not emit any emissions to air or water. Therefore, B1 is not declared in the EPD.

Maintenance, B2

The usage of the ConverLight glass laminate does not entail any specific maintenance as the ConverLight film is encapsulated between two sheets of glass and is not exposed to weather, dust or wear and tear. B2 is therefore not declared.

Repair, B3

The usage of the ConverLight glass laminate does not entail any specific additional repair effort and no repair is declared in the LCA.

Replacement, B4

The usage of the ConverLight glass laminate does not entail any specific additional replacement and no replacement is declared in the LCA.

Refurbishment, B5

The scenario used in this LCA study is a new office building, therefore B5 is not applicable and not declared.

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Operational energy use, B6

The CCU used for ConverLight dynamic glass operation has no power consumption at rest and uses a very little amount of energy for switching shading degree, 0.243 kWh/(declared unit, RSL).

Operational water use, B7

The ConverLight glass laminate has no impact on the buildings water use whereas B7 is not declared.

End-of-life stage, C1-C4

De-construction and demolition, C1

The energy and materials required to dismantle the ConverLight glass laminate and CCU into electronic waste, laminated tempered float glass and frame at the local recycling station is assumed to contribute to less than 1% of the whole energy and mass used and is excluded.

Transport to waste processing, C2

The C2 transports are listed below.

Life Cycle Stage	Cargo	From	To	Distance (km)	How
C2	ConverLight glass laminate	Building site in Stockholm, Sweden	Local recycling station, Stockholm, Sweden	5	Truck, Euro 5, 17.3 t max payload
C2	ConverLight glass laminate	Local recycling station, Stockholm, Sweden	Otterbäcken, Sweden	292	Truck, Euro 5, 17.3 t max payload
C2	ConverLight glass laminate	Otterbäcken, Sweden	Bremen, Germany	980	Container ship, heavy fuel oil, 27500dwt
C2	ConverLight glass laminate	Bremen, Germany	Marienfeld, Germany	182	Truck, Euro 5, 17.3 t max payload

Waste processing for reuse, recovery and/or recycling, C3

The energy used by the recycling company for separating the ConverLight glass laminate into plastic waste for incineration and cullet glass for use as new raw material could not be retrieved from the recycling company and is not reported. The energy used to recycle the electronics waste of the CCU is not known and not declared.

Final disposal of end-of-life construction product, C4

At the glass recycling site, the ConverLight glass laminate is fully recycled as energy or new raw material, therefore no disposal of the glass laminate is done. According to the EPD of the CCU, 6% of the electronics waste of the CCU is disposed, which translates into 0,02 wt% of one declared unit of ConverLight glass laminate (1 CCU for 4 windows with in average 20 m2 of ConverLight glass laminates). This is such small weight percentage of the ConverLight glass laminate that it is not declared.

Benefits and loads beyond the system boundary, D

PET, PVB, and ABS plastic waste are modelled as energy recovery where the benefits from waste incineration are given in the table below.

The glass waste is processed into glass cullet replacing raw material for glass container production but there’s no exact information on how this is done available and hence it is disclosed as Materials for Recycling (MFR). The electronics waste is also modelled as materials for recycling as it's not known how it´s recycled.

Waste	Benefits and loads beyond the system boundary
PVB plastic waste	Incineration of polyethylene waste in a waste to energy plant. Benefits from waste incinerator: calculated based on exported energy from waste processing substituting German average electricity and thermal energy from hard coal at heat plant
PET plastic waste	Incineration of PET waste in a waste to energy plant. Benefits from waste incinerator: calculated based on exported energy from waste processing substituting German average electricity and thermal energy from hard coal at heat plant
ABS (from CCU) plastic waste	Incineration of ABS plastic waste in a waste to energy plant. Benefits from waste incinerator: calculated based on exported energy from waste processing substituting Swedish average electricity and thermal energy from hard coal at heat plant (the major district heating operator in Stockholm uses among others coal)
Packaging (from A5) PE waste	Incineration of PE plastic waste in a waste to energy plant. Benefits from waste incinerator: calculated based on exported energy from waste processing substituting Swedish average electricity and thermal energy from hard coal at heat plant (the major district heating operator in Stockholm uses among others coal)
Packaging (from A5) Wood waste	Incineration of wood waste in a waste to energy plant. Benefits from waste incinerator: calculated based on exported energy from waste processing substituting Swedish average electricity and thermal energy from hard coal at heat plant (the major district heating operator in Stockholm uses among others coal)
Packaging (from A5) paper waste	Incineration of paper waste in a waste to energy plant. Benefits from waste incinerator: calculated based on exported energy from waste processing substituting Swedish average electricity and thermal energy from hard coal at heat plant (the major district heating operator in Stockholm uses among others coal)
Packaging (from A5) EPS waste	Incineration of EPS waste in a waste to energy plant. Benefits from waste incinerator: calculated based on exported energy from waste processing substituting Swedish average electricity and thermal energy from hard coal at heat plant (the major district heating operator in Stockholm uses among others coal)
Float glass waste	Recycled as cullet glass to be used for container glass production Loads and Benefits from recycling: Not known. Disclosed as Materials for Recycling (kg)
Electronic waste from CCU	Recycled as electronic/metal components Loads and Benefits from recycling: Not known. Disclosed as Materials for Recycling (kg)

5 CONTENT DECLARATION

5.1 Product

The mass of a declared unit (1m^2 of ConverLight® glass laminate in the configuration 44.2 with two panes of 4mm tempered float glass and the electrochromic foil laminated in between) is 22,2 kg. The mass and content declaration of the CCU that control up to 20 ConverLight glass laminates is approximated using the EPD with declaration code "M-EPD-SVR-GB-002". The mass of the CCU allocated to 1 declared unit of ConverLight glass laminate is 0,11 kg which is <1 % (wt). The material composition of the ConverLight glass laminate and the CCU is shown below:

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Sputtering targets are placed on a tailormade foam bed in a plywood box for transportation. PET film and PVB film are prepared for transport by wrapping them in protective kraftliner and polyethylene plastic. The CCU is delivered to the Uppsala production plant wrapped in PE film, cardboard, and placed in a wood case. ConverLight® glass laminate is prepared for transport to the IGU manufacturing site by fitting them with protective kraftliner and polyethylene plastic and placing them in an EPS cladded wooden box. Further packaging at the IGU manufacturing facility is omitted from this EPD as it would have taken place also without the ChromoGenics product installed in the IGU. Packaging material waste is modelled as sent to incineration in waste-to-energy plant where the output replaces Swedish Electricity mix and thermal energy from hard coal in a heat plant.

Material of the glass laminate	% of declared unit (wt.%)
Float glass	90
PVB-film (EVA film LCI data used as proxy with the same weight)	7
PET-film	2
Electrolyte, PMMA, PPG, + $LiClO_4$	< 1
In_2O_3:Sn (ITO, transparent conductive oxide)	<< 1
WO_3 (inorganic metal oxide)	<< 1
NiO_x (inorganic metal oxide)	<< 1
Material of the CCU	**% of declared unit (wt.%)**
Steel	<< 1
Copper	<<1
Brass	<<1
Aluminium (solid)	<1
Plastics	<<1
Packaging material	**kg/declared unit**
Polyurethane foam	1.9e-4
Plywood	1.5e-4
PE film	3.1e-3
Timber spruce	3.2e-1
Kraftliner	1.3e-1
EPS	4.1e-2

No Substance of Very High Concern” (SVHC) in concentration above 0.1% by weight under the European REACH regulation (Registration, Evaluation, Authorization and Restriction of Chemicals) is present, neither in the glass laminate nor in the CCU (according to the EPD with declaration code “M-EPD-SVR-GB-002” used as approximation of the CCU).

6 ENVIRONMENTAL PERFORMANCE

The following tables presents the environmental impacts associated with the production, use and disposal (cradle-to-grave) of 1 square meter of ConverLight® glass laminate.

6.1 Environmental impacts

	Product stage	Construction stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
ND=Not declared	Cradle-to-gate	Transport	Construction, Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse/ Recovery/ Recycling potential
Environmental impacts															
Global warming potential, GWP_{GHG} (biogenic GWP_{bio} is excluded) kg CO2 eq./declared unit	3,4E+01	5,8E-01	ND	ND	ND	ND	ND	ND	2,7E-02	ND	ND	9,7E-01	ND	ND	4,4E+00
Ozone depletion (ODP) kg CFC 11 eq./ declared unit	7,1E-07	3,9E-12	ND	ND	ND	ND	ND	ND	7,7E-13	ND	ND	5,5E-12	ND	ND	2,6E-12
Acidification potential (AP) kg SO2 eq./declared unit	2,3E-01	1,4E-03	ND	ND	ND	ND	ND	ND	2,1E-05	ND	ND	1,1E-02	ND	ND	2,9E-04
Eutrophication potential (EP) kg (PO4)3- eq./declared unit	2,4E-02	3,2E-04	ND	ND	ND	ND	ND	ND	5,3E-06	ND	ND	1,3E-03	ND	ND	6,6E-05
Photochemical ozone creation (POCP) kg C2H2 eq./declared unit	-1,9E-02[1]	-4,2E-04	ND	ND	ND	ND	ND	ND	2,1E-06	ND	ND	-1,0E-05	ND	ND	2,4E-05
Abiotic depletion potential for fossil resources (ADP-fossil fuels) (ADPF) MJ/declared unit	4,5E+02	7,4E+00	ND	ND	ND	ND	ND	ND	5,3E-02	ND	ND	1,2E+01	ND	ND	5,4E-01
Abiotic depletion potential for non-fossil resources (ADP-elements) (ADPE) kg Sb eq./declared unit	5,0E-03	3,8E-08	ND	ND	ND	ND	ND	ND	2,7E-08	ND	ND	5,1E-08	ND	ND	2,6E-08

[1] POCP negative due to a negative characterization factor of nitrogen monoxide in the characterization method CML (baseline), v.4.4 of January 2015.

6.2 Resources use

ND=Not declared	Product stage	Construction stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Cradle-to-gate	Transport	Construction, Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse/ Recovery/ Recycling potential
Resources use															
Use of renewable primary energy excluding renewable primary energy resources used as raw materials (PERE), MJ/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Use of renewable primary energy used as raw materials (PERM), MJ/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Total use of renewable primary energy resources (PERT), MJ/declared unit	5,4E+01	4,3E-01	ND	ND	ND	ND	ND	ND	7,0E-01	ND	ND	4,9E-01	ND	ND	1,0E-01
Use of non-renewable primary energy (excluding non-renewable primary energy resources used as raw materials) (PENRE), MJ/declared unit	1,7E+01	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Use of non-renewable primary energy used as raw materials (PENRM), MJ/declared unit	7,4E-02	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Total use of non-renewable primary energy resources (PENRT), MJ/declared unit	4,8E+02	7,5E+00	ND	ND	ND	ND	ND	ND	9,7E-01	ND	ND	1,2E+01	ND	ND	6,1E-01
Use of secondary materials (SM), kg/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Use of renewable secondary fuels (RSF), MJ/declared unit	4,0E-04	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Use of non-renewable secondary fuels (NSRF), MJ/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Net use of fresh water (FW), m3/declared unit	2,9E+01	3,2E-02	ND	ND	ND	ND	ND	ND	8,2E-01	ND	ND	4,6E-02	ND	ND	6,6E-02

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6.3 Waste to disposal

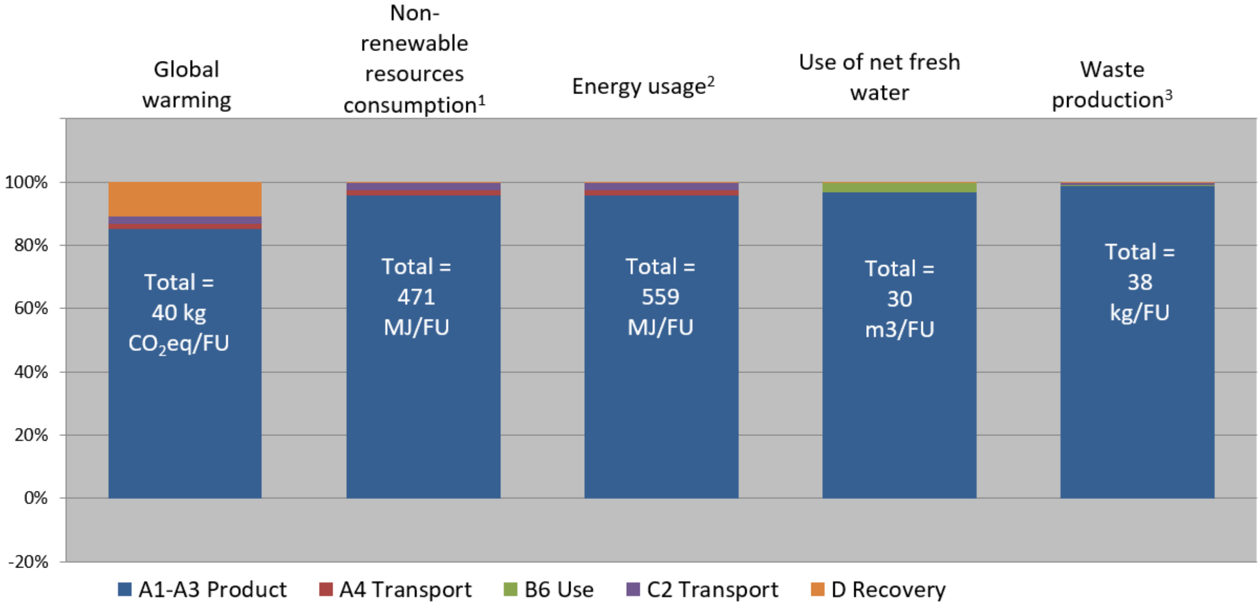
ND=Not declared	Product stage	Construction stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Cradle-to-gate	Transport	Construction, Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse/ Recovery/ Recycling potential
Waste to disposal															
Hazardous waste disposed (HWD), kg/declared unit	1,7E-04	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Non-hazardous waste disposed (NHWD), kg/declared unit	3,8E+01	4,0E-02	ND	ND	ND	ND	ND	ND	1,6E-02	ND	ND	2,8E-01	ND	ND	1,2E-01
Radioactive waste disposed (RWD), kg/declared unit	1,3E-02	1,6E-05	ND	ND	ND	ND	ND	ND	3,8E-04	ND	ND	2,3E-05	ND	ND	2,7E-05

6.4 Output flows

ND=Not declared	Product stage	Construction stage		Use stage							End-of-life stage				Benefits and loads beyond the system boundary
	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Cradle-to-gate	Transport	Construction, Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse/ Recovery/ Recycling potential
Output flows															
Components for reuse (CRU), kg/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Materials for recycling (MFR), kg/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	2,0E+01
Materials for energy recovery (MER), kg/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Exported electrical energy (EEE), MJ/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00
Exported thermal energy (EET), MJ/declared unit	0,0E+00	0,0E+00	ND	ND	ND	ND	ND	ND	0,0E+00	ND	ND	0,0E+00	ND	ND	0,0E+00

7 ADDITIONAL INFORMATION

The figure below describes the five major environmental impacts for the A-D life stages. The GWP impact of the D stage relates to the waste-to-energy recovery of plastic waste which emits carbon dioxide emissions.

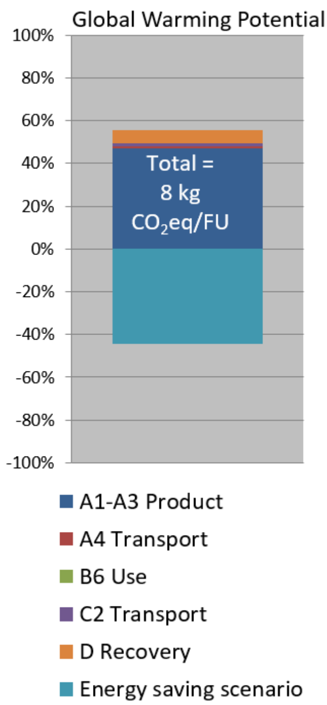


[1] Corresponds to the abiotic depletion potential of fossil resources
[2] Corresponds to the total use of primary energy
[3] Corresponds to the sum of hazardous, non-hazardous and radioactive waste disposed

Energy saving scenario

In the figure to the right the GWP impact is shown for a scenario that highlights the energy savings possibility with the ConverLight dynamic glass. The scenario[2] is an office building in the proximity of Stockholm in Sweden, requiring cooling when the indoor temperature rises above a certain comfort level. Energy use is modelled with the IDA software as energy savings (kWh) per declared unit (1 m^2 ConverLight glass laminate, RSL = 20 years) in an insulated glass unit and for an insulated glass unit with a 2x4 mm laminated tempered float glass without the ConverLight electrochromic film. The ConverLight glass laminate doesn’t transmit as much solar energy as a float glass without electrochromic function, therefore a small amount of additional energy is required for heating in a building with the ConverLight glass laminate. For the scenario this additional heating is modelled as local district heating. The cooling energy is modelled as achieved with a conventional electric powered air conditioning system using electricity from the Swedish grid mix. The results of the IDA calculation is a saving in electricity for cooling of 370 kWh/(RSL, declared unit).

[2]https://www.chromogenics.com/content/uploads/2018/10/simuleringar-energi-inneklimat-och-dagsljus-projektengagemang-20180916.pdf



Large glass façades can often lead to skyrocketing operational and maintenance costs. ConverLight glass laminate in an IGU works as an automatic climate system that blocks unwanted solar heat before it even enters the building, keeping the facilities cool, reducing the need of additional cooling systems. This makes ConverLight a very cost-efficient solution for all buildings. Lower energy use also means a reduced environmental footprint and ConverLight can contribute significantly to the requirements of environmental certification schemes such as BREEAM, LEED, Green Building and the Swedish scheme “Miljöbyggnad”.

8 REFERENCES

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