# Thermobel
# iplus Top 1.1 | iplus Top 1.1$^{T}$
# iplus Advanced 1.0
# Stopray

**for reference compositions:**

**4-16-|4 ; 4|-16-4 ; 4T-16-|4T ; 4-15-|4 ; 4|-15-4 ; 4T-15-|4T;**

**5-16-|4; 5-15-|4;**

**6-16-|4 ; 6T-16-|4T ; 6-15-|4 ; 6T-15-|4T;**

**6-16-|6 ; 6|-16-6 ; 6T-16-|6T ; 6-15-|6 ; 6|-15-6 ; 6T-15-|6T;**


## 1. Summary

**Declaration Holder**

AGC Glass Europe
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www.agc-glass.eu
www.yourglass.com
environment@eu.agc.com

**This Declaration is based on the PCR document:**

Product Category Rules (PCR): Requirements on the EPD for Plate glass of construction - IBU

**Validity date**

This EPD applies to the above-mentioned construction product and is valid until replaced by a new version (evaluation typically 5 years from the date of issue).

**Date of issue**

*Data verified in 2013*

**Construction product**

Double Glazing Unit

**Declared Product / Declared Unit**

The declared unit is 1 m² of double glazing consisting of two glass sheets, separated by a free space filled with thermal gas. The inner or outer glass sheet is covered with a soft coating.

**Scope of validity:**

The Life Cycle Assessment was carried out according to ISO 14040 and ISO 14044. The Environmental Product Declaration was prepared according to EN 15804 and ISO 14025.

**Verification**

CEN standard EN 15804 :2012 serves as core PCR.

## 2. Product

### 2.1 Product description

The product considered for the assessment is double glazing. Thermobel, iplus and Stopray are the brand names for AGC and Interpane insulating glazing units, highly prized for their thermal insulation and solar control.

Reference compositions considered in this EPD:

**4-16-|4** ; 4-15-|4 ; 4|-16-4 ;

4|-15-4 ; 4T-16-|4T ; 4T-15-|4T ;

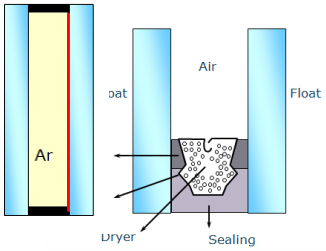
**5-16-|4**; 5-15-|4;

**6-16-|4** ; 6-15-|4 ; 6T-16-|4T ;

6T-15-|4T ;

**6-16-|6** ; 6-15-|6 ; 6|-16-6 ;

6|-15-6 ; 6T-16-|6T ; 6T-15-|6T ;




Magnetron coated glass is treated with a thin transparent coating.
Low emissivity (low E) coating reflects heat back into the building, thereby reducing the heat loss through the window. It also reduces the heat transfer from the warm (inner) pane to the cooler (outer) pane, thus further lowering the amount of heat that escapes from the window. These properties reduce the amount of energy to heat the building. In addition, the coating allows large amounts of free solar energy to enter the building, thereby heating it passively.

Solar control coating offers solar protection and thermal insulation.

### 2.2 Application & delivery status

Insulating glazing units are tailor made products, delivered in a wide variety of dimensions, applicable in all kinds of configurations.

### 2.3 Technical Data

Technical data for the declared unit (4-16-|4):

- Thermal transmission (EN 673): $U_g$ = 1.1-1.0 W/(m².K)
- Light transmission (EN 410): Tv = 78 %
- Light reflection (EN 410): $\rho_v$ = 13 %
- Solar factor (EN 410): 60 %

Further data on: www.yourglass.com

### 2.4 Relevant product standard

The product complies with EN 1279-5:2005+A2:2010.

### 2.5 Base materials / Ancillary materials

Flat glass production:

- The sheets of flat glass used in the fabrication of insulating glazing are in accordant with EN 572-1:2012 for building products that defines the magnitude of the proportions by mass of the principal constituents of float glass.

Composition of the declared unit (% of total mass):

- glass: 95%
  - outer sheet: 4 mm float or soft coated glass sheet;
  - inner sheet: 4 mm float or soft coated glass sheet.
- spacer, dryer and thermal gas: 2,6%
  - 16 mm thick of aluminium, galvanized steel or co-extruded spacer;
  - zeolite (to avoid condensation);
  - argon.
- sealants: 2,4%
  - polyisobutylene (first barrier);
  - polysulfide, polyurethane or silicone (second barrier).

No substances of the “Candidate List of Substances of Very High Concern for Authorisation (or SVHC)”, exceeding the concentration in article threshold, in the declared unit.

### 2.6 Manufacturing & Processing

The basic principle of the float glass process is to mix the raw materials, melt them in the furnace and pour the molten glass onto a bath of molten tin. The combustion in the furnace uses air and natural gas / fuel oil. The glass solidifies as it floats on the thin bath. After the tin bath, the glass ribbon passes on to an annealing zone where it cools down gradually while being carried on rollers. At the end of this zone the glass is cut into sheets.

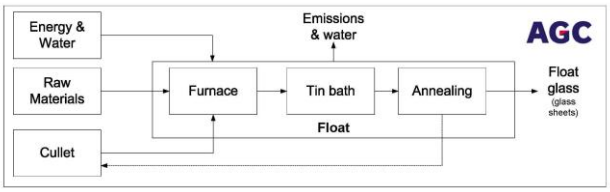



**Figure 1** – Flat glass manufacturing

The soft coating is applied with the magnetron sputtering vacuum deposition. The glass is washed, inspected before it enters the coating zone (vacuum) via the buffer.

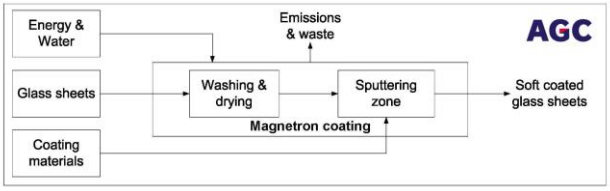



**Figure 2** – Process flow magnetron sputtering vacuum deposition

The assembly of insulating glazing units is executed on a fully automated line. The glass sheets are cut to dimensions, cleaned with water and after drying controlled for defects. The spacer bar is cut to dimensions, bent, assembled, filled with zeolite (dryer) and marked with a unique code (see chapter 8). The spacer is applied on the glass plates with butyl sealant, the thermal gas is injected and the outer sealant is applied.

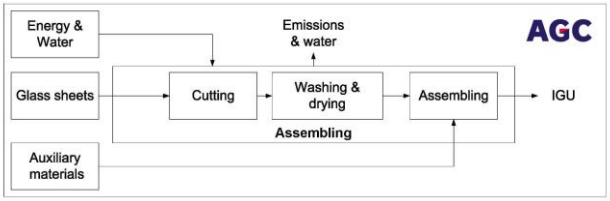



**Figure 3** – Process flow diagram insulating glazing unit

Input data were gathered from fifteen European based AGC float lines, two European based AGC magnetron coaters, ten European based AGC sites involved in insulating glazing assembly and the European AGC R&D centre.

All manufacturing and processing sites operate under a certified quality management system.

### 2.7 Environmental and health during manufacturing

AGC plant managements are committed to the group environmental and safety policy. At group or division level specific programmes are defined to act as guidelines for the country organisations and plants. Key performance indicators (KPI's) have been selected, are reported and are reviewed on a regular basis.

All glass manufacturing plants obtained ISO 14001 and OHSAS 18001 certification, as did the main processing plants.

### 2.8 Product processing / Installation

Not relevant. The construction process stage is not in the system boundary.

### 2.9 Packaging

Flat glass and insulating glazing units are warehoused and transported in vertical position: flat glass by inloader trucks (dedicated trailer stillage combinations), insulating glazing units on reusable metal stillages. Wood, cardboard and metal ropes are used for fixation, plastic film can be used for additional protection.

### 2.10 Condition of use

Not relevant. The use stage is not in the system boundary.

### 2.11 Environment and health during use

Intended usage of insulating glazing units does not entail adverse environmental or health effects. No dangerous substances are released during the use of the product (see also point 5). On the contrary, the use of insulating glazing in residential and in commercial buildings leads to energy savings and thus makes it possible to avoid $CO_2$-emissions (see chapter 8 ).

### 2.12 Reference service life

The reference service life (RSL) for an insulating glazing unit is set at 30 years.

The RSL does not reflect the actual life time which typically is set by the lifetime and refurbishment of a building. The RSL is not referring to the warranty either.

### 2.13 Extraordinary effects (Fire, water, Mechanical destruction)

Not relevant.

### 2.14 Re-use phase

Glass is recyclable. Glass cullet from manufacturing and processing is commonly reintroduced in the glass manufacturing process. It decreases the required energy input for the furnaces. Cullet represents on average 30% of flat glass mass manufactured by AGC, at average 4% coming from outside the glass manufacturing plant (pre-consumer cullet - reference year 2009).

Nowadays about 5% of end-of-life insulating glazing units are dismantled, collected separately and recycled for glass manufacturing (post-consumer cullet); about 95% ends up in demolition waste.

### 2.15 End-of-Life

The following waste codes (EU-codes according to Commission Decision 2000/532/EC and Annex III to Directive 2008/98/EC) can apply:

- 10 11 12 – waste glass from manufacture of glass and glass products (pre-consumer glass cullet);
- 17 02 02 – glass from construction and demolition waste (end-of-life glass);
- 17 09 02 – insulating glazing units containing PCBs (can apply to end-of-life glass, for units produced from approx. 1965 to 1975).

## 3. Life Cycle Assessment (LCA) - Calculation rules

### 3.1 Calculation rules

This EPD reports the results of the LCA in which the environmental impacts generated by material and energy flows involved in the manufacturing of float glass, the magnetron coating process and the assemblage of the insulating glazing units are modelled and calculated. The LCA was performed in accordance with the product category rules set out in the European standard EN 15804 and the LCA principles and requirements set out of ISO 14040 and ISO 14044.

### 3.1 Declared unit

The declared unit is 1 m² of double glazing consisting of two glass sheets, separated by a free space filled with thermal gas. The inner or outer glass sheet is covered with a soft coating.

### 3.2 System boundary

This is a cradle-to-gate EPD, which covers a system boundary including raw materials & energy supply, manufacturing & processing of flat glass to an insulating glazing unit, with associated transport (A1-A3). The installation and use stage is due to the diversity of application and construction not included in the calculation.

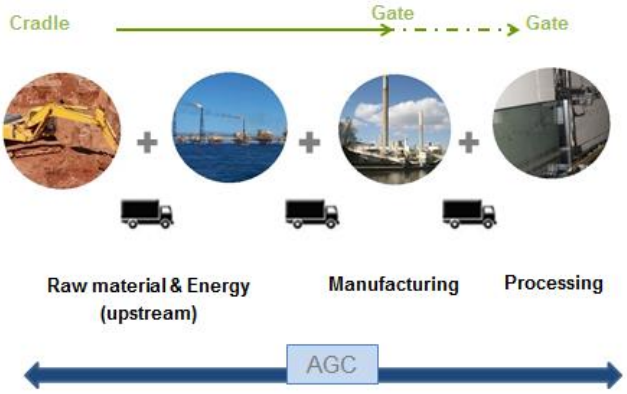



**Figure 3** – System boundary "cradle-to-gate"

### 3.3 Data quality & Background data

Primary data on input/output and transport were collected from European based AGC production plants: 10 float sites (18 float lines), 2 magnetron coating plants, 10 sites involved in insulating glazing assembly, and the AGC R&D centre. Other relevant data were obtained from manufacturer's information (e.g., product composition). Data were cross checked with primary data of Interpane sites for each of the production stages.
The production volumes of these sites were used to determine average values (weighted averages).

Background data were used from the GaBi 6 database (2012). European data sets were used for raw materials,

auxiliary materials, energy, water and transport. Data choices focussed on including the best fitting alternatives for all processes in the LCA-model.
The life cycle inventory (LCI) results were modelled and calculated using the GaBi software tool and a life cycle impact assessment (LCIA) was performed.

### 3.4 Period under review

The period under review is one year. Data from 2009 were utilized for this study, completed with data from 2008, 2010 or 2011.

### 3.5 Estimates and assumptions

Different sealant and spacer types are used (see point 2.6). Spacer and sealant types were accounted according to their market share. Non reusable packaging was considered.

Road transports were considered to return empty, transport per ship with a load. Operational data on transport distances were completed with estimates for local supplies (e.g., packaging). An average distance of 100 km was considered for these local supplies, all by road transport.

Spacer thickness, dryer, thermal gas and sealants quantity modelling for other than the basic composition (16mm) was conducted using the same proportional variation for these inputs.

### 3.6 Cut-off criteria

The production of the required machinery and equipment have not been considered.

Operational data (raw materials, energy, auxiliary and operating materials, waste, emissions to air and water) were utilised in the calculation. Also known material and energy flows of less than 1% were accounted.

It can be assumed that the total of negligible processes does not exceed 5%.

### 3.7 Allocation

There is no allocation of co-products for the manufacturing and processing under consideration in this EPD.

### 3.8 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all data sets to be compared were created according to EN15804:2012 and the building context, respectively the product-specific characteristics of performance, are taken into account.

## 4. Life Cycle Assessment (LCA) - Inventory & Interpretation

### 4.1 Description of the system boundary

The product stage is covered by this EPD (see point 3.2):

- Raw materials supply (A1);
- Transport (A2);
- Manufacturing & processing (A3).

Below a selection of indicators is presented for the declared unit, being 1 m² of double glazing consisting of two glass sheets, separated by a free space filled with thermal gas. The inner or outer glass sheet is covered with a soft coating.

These indicators describe different types of environmental impact (e.g., global warming), input needs of resources (e.g., fresh water, energy) and output flows (e.g., waste) for the declared unit for a selected number of compositions with the same technical properties ($U_g$ ,Tv, $\rho_v$, solar factor)

### 4.2 Environmental impact indicators

The CML 2001 life cycle impact assessment method was used. The impact indicators are presented below.

| Parameter | | Unit | A1-3 | A1-3 | A1-3 | A1-3 |
|---|---|---|---|---|---|---|
| | | | 4-16-\|4 (1) | 5-16-\|4 (2) | 6-16-\|4 (3) | 6-16-\|6 (4) |
| Global warming potential (100 years) | GWP | [kg $CO_2$-eq.] | 36,7 | 40,4 | 44,2 | 52,4 |
| Ozone depletion potential – stratospheric ozone layer | ODP | [kg CFC11-eq.] | 4,18E-8 | 4,53E-8 | 4,89E-8 | 5,64E-8 |
| Acidification potential | AP | [kg $SO_2$-eq.] | 0,228 | 0,253 | 0,278 | 0,330 |
| Eutrophication potential | EP | [kg $PO_4^{3-}$- eq.] | 0,029 | 0,032 | 0,035 | 0,042 |
| Photochemical ozone creation potential | POCP | [kg Ethene eq.] | 0,015 | 0,016 | 0,018 | 0,021 |
| Abiotic depletion potential for non-fossil resources | ADPE | [kg Sb eq.] | 1,41E-4 | 1,54E-4 | 1,67E-4 | 1,92E-4 |
| Abiotic depletion potential for fossil resources | ADPFE | [MJ] | 486 | 532 | 578 | 677 |

The environmental impacts of insulating glazing units are primarily determined by the manufacturing of the flat glass, the basic material of insulating glazing units. It contributes for about:

- 80 % to the global warming potential (GWP), which is mainly due to carbon dioxide emissions;
- 60 % to ozone depletion potential (ODP), predominantly due to upstream processes for some raw and packaging materials (e.g., dolomite, wood treatment, steel)
- 87 % to the acidification potential (AP), mainly arising from sulphur dioxide and nitrogen oxides emissions;
- 88 % to the eutrophication potential (EP), where nitrogen oxides emitted are the main contributor;
- 82 % to the photochemical ozone creation potential (POCP), predominantly as a result of sulphur dioxide and nitrogen oxides emitted;
- 68 % to the abiotic depletion potential of non-renewable material resources (ADPE), mainly arising from upstream sodium chloride (rock salt) which is required to produce sodium carbonate (a raw material for flat glass);
- 74 % to the abiotic depletion potential for fossil resources (ADPFE), predominantly due to fossil fuels used in the glass manufacturing process and fossil fuels and uranium for electricity provision.

The coating process and the spacers contribute to a lesser extent. The electricity provision for the coating process, the upstream processes of materials (e.g.,, steel) having the second largest influence on the main impact indicators. The influence of the sealants, thermal gas and packaging materials is less.

**Estimate for other glass sheet or spacer thicknesses:**

All indicators are dominated by the manufacturing of the glass sheets. On the basis of the results conservative estimates of environmental indicators, resources uses and waste quantities can be made for other compositions with the same technical properties ($U_g$ ,Tv, $\rho_v$ , solar factor):

- By applying the ratio of the total glass thickness to the glass thickness 4-16-4 composition to the main impact indicators.
- The contribution to the environmental impact indicators by the glass manufacturing overrules the contribution of soft coating (which represents approximately 10 % of the impacts calculated for the declared unit.
- When modifying the width of the spacer with 1 mm the main impact indicators modify by 0,5 to 1 %. Modifying the spacer width implies a modification of the quantity of sealant, dryer and argon as well.

### 4.3 Resource uses

| Parameter | | Unit | A1-3 | A1-3 | A1-3 | A1-3 |
|---|---|---|---|---|---|---|
| | | | 4-16-\|4 (1) | 5-16-\|4 (2) | 6-16-\|4 (3) | 6-16-\|6 (4) |
| Primary energy resources, total renewable | PERT | [MJ] | 30,2 | 32,2 | 34,2 | 39,3 |
| Primary energy resources, total non-renewable | PENRT | [MJ] | 486 | 532 | 578 | 677 |
| Fresh water use | FW | [m³] | 31,7 | 33,2 | 34,2 | 39,3 |

(1) 4-16-|4; 4|-16-4; 4T-16-|4T ; 4-15-|4 ; 4|-15-4 ;; 4T-15-|4T ;
(2) 5-16-|4; 5-15-|4;
(3) 6-16-|4 ; 6T-16-|4T ;
(4) 6-16-|6 ; 6|-16-6 ; 6T-16-|6T ; 6-15-|6 ; 6|-15-6 ; 6T-15-|6T .

The primary energy use related to the production of insulating glazing units (516 MJ) is dominated by the production of the flat glass sheets (72 %). Heavy fuel and natural gas are significant energy sources (non renewables) in the manufacturing process.

Used non-renewable material resources are mainly sodium chloride (rock salt – 52 %) required for the production of sodium carbonate and to a lesser extent to sodium sulphate (6,5%), both related to flat glass manufacturing. Upstream processes of auxiliary materials involving mining ores, such as steel for spacers and metal straps for packaging, contribute as well. Mining ores and energy resources (e.g., coal for electricity production) also result in waste rock.

The fresh water demand is for about 37% due to upstream processes of electricity and raw materials for flat glass production (e.g., sodium carbonate). The upstream processes of spacer materials production having the second largest impact on this indicator (26%).

### 4.4 Waste categories

| Parameter | | Unit | A1-3 | A1-3 | A1-3 | A1-3 |
|---|---|---|---|---|---|---|
| | | | 4-16-\|4 (1) | 5-16-\|4 (2) | 6-16-\|4 (3) | 6-16-\|6 (4) |
| Hazardous waste disposed | HWD | [kg] | 0,0198 | 0,0204 | 0,0210 | 0,0222 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Non-hazardous waste disposed | NHWD | [kg] | 20,6 | 22,9 | 25,3 | 30 |
| Radioactive waste disposed | RWD | [kg] | 0,0152 | 0,0162 | 0,0172 | 0,0201 |

The non-hazardous waste is mainly generated by the processes upstream for spacer materials, packaging and sealants. The hazardous waste is predominantly due to the same upstream processes. Radioactive waste is generated exclusively linked to electricity supply (nuclear power stations).

## 5. Requisite evidence

**Volatile organic compounds (VOC)**
Thermobel is labelled in the top category "*A+*" following accredited testing, in accordance with the French *Décret No. 2011-321 du 23 mars 2011*, completed by *l'Arrêté du 19 avril 2011* with regard to the labelling of construction products on emissions of volatile compounds.

## 6. Additional information

### 6.1 Energy savings by the use of AGC low E double glazing

AGC low E double glazing helps to keep the heat inside or outside, reducing the need for heating or cooling. Both heating and cooling consume energy (and thus lead to $CO_2$-emissions), so reducing these needs makes it possible to avoid $CO_2$-emissions.

Did you know?

The manufacturing of 1m² of AGC low E double glazing leads to the emission of 36,5 kg of CO2. On the other hand, 47 to 196 kg of $CO_2$ per year (at average 121 kg) are saved by replacing 1m² of single glazing with AGC low E double glazing. The savings are the highest in cold regions.

The $CO_2$ emitted during production is thus offset after only a few months of use (at average <4,5 months):

- Moscow (East): <2,5 months;
- Helsinki (North): <3,5 months;
- Praha (Central) and Sofia (South central): 3,5 months;
- Frankfurt (Central continental): <4 months;
- Brussels (Central maritime): <4,5 months;
- Roma (South): <9,5 months.

Further information on $CO_2$-savings and sustainable buildings can be consulted in the AGC Environmental Report: www.agc-glass.eu

### 6.2 Glass identity code of AGC insulating glass

The spacer bar of each insulating glazing unit is marked with a unique identity code (AGC - brand name – production related data - name of the coating). With this code exact technical data can be retrieved via the AGC Glass Identity application (www.yourglass.com - glass identity). This code provides, amongst others, valuable information for end-of-life options.

## 7. References

**EN 15804**
Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products.

**ISO 14025**
Environmental labels and declarations — Type III environmental declarations

**NF P01-10**
Qualité environnementale des produits de construction – Déclaration environnementale et sanitaire des produits de construction.

**PCR 2011, Part A**
Institut Bauen und Umwelt e.V., Königswinter (pub.): Product Category Rules for Construction Products from the range of Environmental Product Declarations of Institut Bauen und Umwelt (IBU), Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report. July 2011
www.bau-umwelt.de

**PCR Guidance Text for Building-Related Products and Services, Part B**
Requirements on the EPD for Plate glass for construction

**EeB Guide**
EeB Guide – Part A (October 2012): Operational guidance for the preparation of LCA studies for energy-efficient buildings and building products.

**GaBi 6**
GaBi version 6 database 2012 (release 2013) – PE International

**EN 572-1**
Glass in building. Basic soda lime silicate glass products. Definitions and general physical and mechanical properties.