Łukasiewicz
Instytut Ceramiki
i Materiałów Budowlanych

FAKRO

ENVIRONMENTAL PRODUCT DECLARATION

No. 02-11/2022

FLAT ROOF WINDOWS

FAKRO PP Sp. z o.o

Owner of the EPD:	*FAKRO PP Sp. z o.o.*
Programme owner:	*Łukasiewicz Research Network – Institute of Ceramics and Building Materials* *Environmental Engineering Center*
Name of programme:	*Deklaracje Środowiskowe Produktów – B2B*
Issued:	***10.11.2023***
Valid until:	***10.11.2028***



1. GENERAL INFORMATION

Owner of the EPD: FAKRO PP Sp. z o.o.	**Products covered by the EPD:** Flat roof windows
Programme owner: Łukasiewicz Research Network - Institute for Ceramics and Building Materials Environmental Engineering Center **http://www.icimb.pl/opole/**	**Owner of the EPD:** FAKRO PP sp. z o.o. 144a Węgierska Str. 33-300 Nowy Sącz Telephone: +48 18 444-0-444 Fax: +48 18 444-0-333 E-mail: fakro@fakro.pl **https://www.fakro.com/**
Date of issuance: 10.11.2023	**Declared product/declared unit:** The declared unit (DU) for the products covered by the EPD is 1 m^2 (1 square meter) flat roof windows.
EPD valid until: 10.11.2028	**Scope:** The declaration covers product groups (flat roof windows): • **with single-chamber glazing units P2, P4;** • **with double-chamber glazing units DU6, U6, DU6 Secure, DW6;** • **with a three-chamber glazing package U8 VSG, DU8, DU6 Secure**, manufactured at FAKRO PP Sp. z.o.o. in Nowy Sącz, 144a Węgierska Str. It contains information about the impact of the declared products on the environment. All data on the production cycle have been collected by FAKRO PP Sp. z o.o. from January 1,2022 to December 31, 2022 (12 months) and corresponded to the production's technology of that time. These are averaged data, determined separately for the three groups of products based on the share of declared products in total production in company. The life cycle assessment was developed in accordance with the requirements of PN-EN ISO 15804 + A2: 2020, PN-EN ISO 14025 and PN-EN ISO 14040. The product categorization rules were adopted in accordance with PN-EN 15804. The owner of the declaration is responsible for the information and underlying evidence. The Łukasiewicz Research Network - Institute of Ceramics and Building Materials, Environmental Engineering Center is not responsible for the manufacturer's

	information, data and evidence regarding the life cycle assessment. Declarations resulting from different programs or not performed according to the standards may not be comparable.
Product category rules (PCR)	According to: PN-EN 15804 + A2: 2020-03 Sustainability of construction works. Environmental product declarations. Basic principles of categorization of construction products.
Representativeness:	Polish product, year 2021/2022
Reference Service Life (RSL):	25 years
Reasons for performing LCA:	B2B
Life Cycle Analysis (LCA):	LCA covers modules A1-A3, C1-C4 and D according to PN-EN 15804+A2 standard (Cradle-to-Gate with options)
Łukasiewicz Research Network - Institute of Ceramics and Building Materials, Environmental Engineering Center provides access to the type III EPD for aluminum clad-PVC roof windows made by FAKRO PP Sp. z.o.o to the interested parties.	
Authors: Ewa Głodek-Bucyk, PhD Eng . Katarzyna Kiprian, MSc Eng. **Approved by:** Joanna Poluszyńska, PhD  Director of the environmental engineering center Ewa Głodek-Bucyk, PhD Eng.  Leader of Process Engineering Research Group	**Verification:** CEN PN-EN 15804+A2 standard serves as main PCR. Independent EPD and data verification according to PN-EN ISO 14025:2010 standard. ☐ internal ☒ external  Katarzyna Grzesik, PhD Eng.

2. MANFACTURER AND PRODUCT DESCRIPTION

FAKRO Group is an international company operating in the construction industry since 1991. Employing more than 4,000 people, the FAKRO Group comprises 11 manufacturing companies and 17 distribution companies. FAKRO's product range includes primarily:

- Wooden and aluminium-plastic roof windows of various designs and opening methods. In addition to roof windows, the product range includes, windows for flat roofs,
- Flashings, electrical controls, loft ladders, hatches, tubular skylights, smoke extraction,
- Accessories for roof windows: blinds, curtains, internal and external blinds, external awnings, accessories for roof windows, and external blinds, external awnings, mounting accessories, films, and membranes.

The company's headquarters are in Nowy Sacz, where FAKRO has more than 230,000 m2 of production, storage and office space at its disposal. The environmental impact of the products purchased is becoming increasingly important for both consumers and producers. Therefore, the production process at FAKRO is subject to numerous evaluations, which has been confirmed by numerous certificates awarded to FAKRO. Windows for flat roofs are certified by FIRES and and IFT Rosenheim.

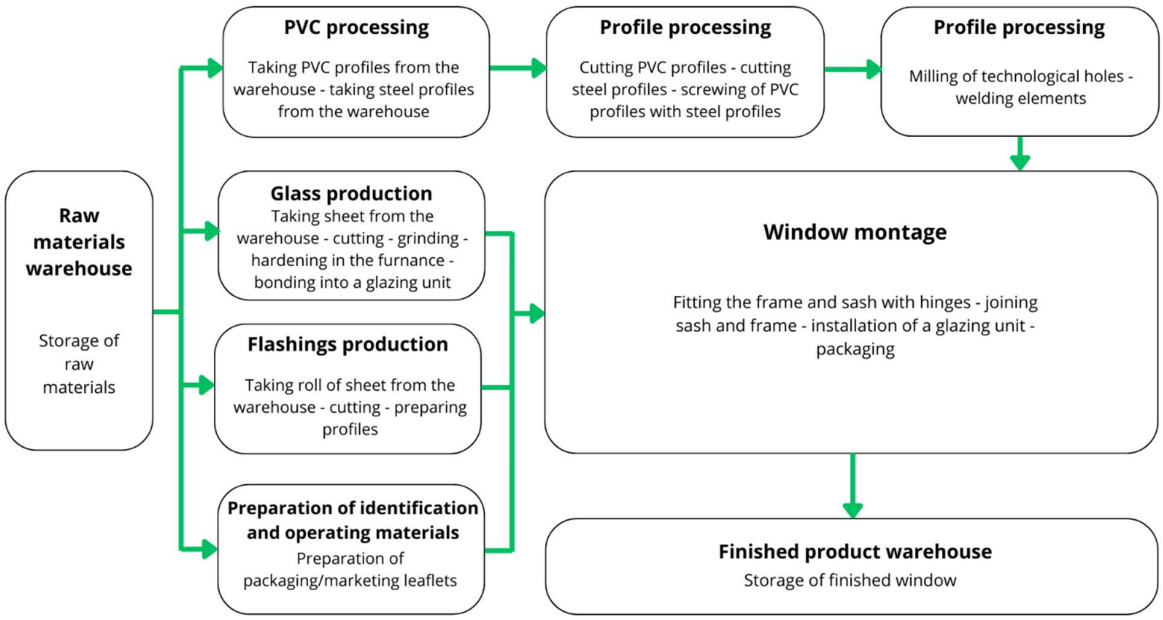
The materials for roof windows are made are:

- PVC profiles - main material,
- Glass – single, double, or triple glazing units,
- Steel - elements of the windows frame,
- Aluminum – cladding and windows fittings,
- Zinc - window hardware,
- Plastics (ABS, PA6, PE, POM, TPE) - additional windows elements,
- EPS - insulation material used in windows frames,
- Silicone – sealings of glazing units,
- Wood - reinforcing elements.

The production of windows for flat roofs begins with the collection of materials from the warehouse, which are then directed to the relevant departments for component processing. Glazing units, PVC profiles and windows frames are processed.

The prepared components are taken to the assembly line, where they are joined together according to the specifications of the individual models. The finished product is packaged and protected for transport and then directed to the finished goods warehouse.

Figure 1: Production diagram of windows for flat roof windows produced by Fakro PP Sp. z o.o.



The purpose of flat roof windows is to provide daylight to rooms situated under a flat roof. Very good insulation performance, a large amount of natural light, the option of ventilation and easy operation of windows make them products that ensure full comfort of living in such spaces.
The frame and sash are made of multi-chamber PVC profiles, partly made of recycled material. Profiles are filled inside with insulating material, thus additionally improving the energy saving parameters of the product. Windows come in non-opening version (DX_), opened manually (DM_) and opened electrically (DE_ Z-Wave, WiFi, WiFi Tuya, Solar, Electro 230 and 24).
FAKRO offers a wide range of flat roof windows to satisfy a variety of customer needs and preferences:

- Type F windows (eg. DXF, DMF, DEF) with a glazing unit having a so-called steppe, mounted using bonding technology to ensure high durability and aesthetic appearance. Available in the Secure version with additional security features and reinforced glazing unit as well as in the ColourLine option to match the colour scheme to the roof style. Recommended for installation in roofs with pitches from 2° to 15°.

- Type C windows (eg. DXC, DMC, DEC) equipped with a polycarbonate dome resistant to mechanical damage in a matt or transparent version. Special coatings on the outer and inner surface of the dome protect it against UV radiation. They are also available in the anti-burglary Secure option with a reinforced glazing unit and additional security features. Recommended for installation in roofs with pitches from 0° to 15°.

- Type G windows (eg. DXG, DMG, DEG) covered from the top with a special glass section that consists of 4 mm or 6 mm thick toughened glass depending on the size and combined with a unique aluminium black profile. The glass section is factory applied to the window which substantially reduces its installation time. This design is based on solutions incorporated into type C windows. Recommended for installation in roofs with pitches from 2° to 15°(for larger sizes, from 5° to 15°).

- Type Z windows (eg. DXZ-A AMZ/Z, DMZ-A AMZ/Z, DEZ-A AMZ/Z, DXZ-B AMZ/Z, DMZ-B AMZ/Z, DEZ-B AMZ/Z) equipped with a specially constructed glass section with a slope on the outer surface to allow drainage of water. A factory fitted AMZ/Z Z-Wave awning blind is placed under the glass section. Windows are available in two versions: D_Z-A with a welded glass section and D_Z-B with a riveted glass section. This design is based on solutions incorporated into type G windows. Recommended for installation in roofs with pitches from 0° to 15°.

- Access roof lights/roof access doors DR_ (eg. DRF, DRC, DRG, DRL) enable safe access to the flat roof. Available in four versions:
  - with a glazing unit with a so-called steppe (recommended for installation in roofs with pitches from 2° to 15°),
  - with a dome (recommended for installation in roofs with pitches from 0° to 15°),

- with a glass section (recommended for installation in roofs with pitches from 2° to 15°),
- with a PVC-XPS-PVC sandwich panel instead of a glazing unit (recommended for installation in roofs with pitches from 0° to 5°).

The used hinges allow the sash to be opened up to 60° or 80° depending on the size.

- Smoke ventilation windows DS_ (DSF, DSC) used for extraction of smoke and heat emitted during a fire, allowing people to evacuate quickly. Windows can be equipped with two or four actuators for free sash lift. They come in two versions:
  - with a glazing unit with a so-called steppe,
  - with a dome.

Recommended for installation in roofs with pitches from 0° to 15°.

- Walk-on DXW windows available only in non-opening version. They are equipped with a special glazing unit, which in combination with reinforced sash and base design, allow for walking across window surface. The outer pane has a non-slip coating that minimises the risk of slipping. Recommended for installation in roofs with pitches from 0° to 15°.

Windows are available with double, triple and quadruple-glazed units, while their configurations are included in the Environmental Product Declaration:

- Double-glazed units, eg.:
  - P2 (4H-14-33.2; 4H+4H-14-33.2; 6H+4H-14-33.2)
  - P4 (4H-14-33.4; 4H+4H-14-33.4; 6H+4H-14.33.4)
- Triple-glazed units, eg.:
  - U6 (6H-18-4HT-18-33.2T)
  - DU6 (6H-18-4H-18-44.2; 6H-16-4H-18-55.2)
  - DU6 Secure (6H-18-4H-18-44.4; 6H-16-4H-55.4)
  - DW6 (888.44-16-4H-18-66.2)
- Quadruple-glazed units, eg.:
  - U8 VSG (4H-10-4HT-12-4HT-12-33.2T)
  - DU8 (6H-10-4HT-10-4HT-12-44.2T; 6H-10-4HT-10-4HT-10-55.2)
  - DU8 Secure (6H-10-4HT-10-4HT-12-44.4; 6H-10-4HT-10-4HT-10-55.4)

The performance characteristics of windows are specified in their declarations of performance, which can be downloaded from the company's website. These values for individual windows vary depending on the model and type of glazing unit. Moreover, DSC-C and DSF windows are FIRES certified.

The specification of windows included in this declaration is given in the table below.

Product name	Glazing unit	Construction of the glazing unit	Resistance to wind load	Reaction to fire	External fire performance	Watertightness. Non-shielded (A)	Impact resistance	Acoustic performance [dB]	Thermal transmittance U [W/m²K]	Air permeability
D F	DU6 DU6 Secure DU6/FK	6H-18-4H-18-44.2 6H-16-4H-18-55.2 6H-18-4H-18-44.4 6H-16-4H-18-55.4	Class C5/B5 Class C2/B2	B-s2,d0	B_{ROOF} (t1)	Class E1200	Class 5 - 950mm	34 (-1, -4)	0,70	Class 4
	DU8 DU8 Secure DU8/FK	6H-10-4H-10-4H-12-44.2 6H-10-4H-10-4H-12-44.4 6H-10-4H-10-4H-12-55.4						33 (-1, -3)	0,64	
D G	P2	4H + 4H-14-33.2 6H + 4H-14-33.2	Class C5/B5	B-s2,d0	B_{ROOF} (t1)	Class E1200	Class 5 - 950mm	36 (-1, -4)	0,92	Class 4
	P4	4H + 4H-14-33.4 6H + 4H-14-33.4								
D Z	P2	4H + 4H-14-33.2 6H + 4H-14-33.2	Class C5/B5	B-s2,d0	B_{ROOF} (t1)	Class E1200	Class 3 - 450mm	npd	0,95	Class 4
	P4	4H + 4H-14-33.4 6H + 4H-14-33.4								
DRF	DU6 DU6 Secure DU6/FK	6H-18-4H-18-44.2 6H-18-4H-18-44.4 6H-16-4H-18-55.2 6H-16-4H-18-55.4	Class C5/B5	B-s2,d0	B_{ROOF} (t1)	Class E1200	Class 5 - 950mm	38 (-1, -3)	0,74	Class 4
	DU8 DU8 Secure DU8/FK	6H-10-4H-10-4H-12-44.2 6H-10-4H-10-4H-12-44.4						37 (-1, -3)	0,69	
DRG	P2	4H + 4H-14-33.2 6H + 4H-14-33.2	Class C4/B4	B-s2,d0	npd	Class E1200	Class 5 - 950mm	35 (-2, -5)	1,0	Class 4
	P4	4H + 4H-14-33.4 6H + 4H-14-33.4								
DRL	-	-	Class C5/B5	B-s3,d0	B_{ROOF} (t1)	Class E900	Class 5 - 950mm	30 (0, -2)	0,67	Class 4
DXW	DW6	888.44-16-4H-18-66.2	Class C5/B5	B-s2,d0	B_{ROOF} (t1)	Class E1200	Class 5 - 950mm	npd	0,70	Class 4

Product name	Glazing unit	Construction of the glazing unit	Resistance to upward load	Resistance to downward loads	Reaction to fire	External fire performance	Water tightness	Impact resistance, small hard body	Impact resistance, large soft body	Thermal transmittance U [W/m2K]	Direct airbone sound insulation [dB]	Air permeability
D C	P2	4H-14-33.2	UL 1500	DL 2500	B-s2,d0	B_{ROOF} (t1)	pass	pass	SB 1200	1,2	35 (-1, -3)	Class A3 (DXC) Class 4 (DMC, DEC)
	P4 Secure	4H-14-33.4								1,2	35 (-1, -3)	
	U6	6H-18-4HT-18-33.2T								npd	npd	
	U8 VSG	4HT-10-4HT-12-4HT-12-33.2T								0,72	36 (-1, -4)	
DRC	P2	4H-14-33.2	UL 1500	DL 2500	B-s2,d0	B_{ROOF} (t1)	pass	pass	SB 1200	0.93	35 (-1, -3)	Class 4
	P4	4H-14-33.4										

Product name	Glazing unit	Construction of the glazing unit	Window dimensions [cm]	Number of actuators	Aerodynamic free area of the product [m²]	Wind load	Snow load	Low ambient temperature	Reliability	Resistance to heat	Reaction to fire
DSC-C2 DSC-M2	P2	4H-14-33.2	100x100	2	0,44	WL 2000	SL 450	T (-05)	Re 1000 + 10 000	B 300	E
			120x120	2	0,57						
DSC-C4 DSC-M4			100x100	4	0,44		SL 1200				
			120x120	4	0,57						
DSF	DU6	6H-18-4H-18-44.2 6H-16-4H-18-55.2	100x100	2	0,45	WL 3000	SL 1200	T (-05)	Re 1000 + 10 000	B 300	E
			105x105	2	0,49						
			110x110	2	0,52						
			115x115	2	0,57						
			120x120	2	0,61						

3. LCA: CALCULATION RULES

System boundaries

The life cycle analysis of the tested products includes A1-A3, C1-C4 and D (Cradle to Gate with options) modules in accordance with PN-EN 15804. It includes the following modules:

- A1 - extraction and preparation of raw materials, generation of electricity and energy carriers for auxiliary processes,
- A2 - transport of raw materials to the gate of the production plant,
- A3 - production, including ancillary processes and emissions.
- C1 – deconstruction/demolition,
- C2 – transport to the waste processing facility,
- C3 – processing of waste material,
- C4 – treatment of waste material,
- D – re-use potential.

Data collection period

Data on the production process was collected in the year 2022, in the period from 01/01/22 to 31/12/22.

Declared unit (DU)

Due to neglegible differences between the two groups of products, the declared unit of 1 m^2 of flat roof window produced by FAKRO PP Sp. z o.o. in Nowy Sącz.

Assumptions

A1 - extraction and consumption of raw materials refers to specific mass shares in the production process per declared unit of the product,

A2 - distances from the place of obtaining raw materials to the production plant individual for each raw material, means of transport differentiated due to the method of raw materials delivery,

A3 - values of CO2, NOx, SO2, dust from the production process received from the customer, others estimated on the basis of fuel consumption.

C1 – describes the disassembly of the flat roof window at the end of its life. The impact category values for this module are negligible and have been assumed to be zero.

C2 – refers to the transportation of used flat roof windows to a waste recovery or disposal facility. Data is collected based on a developed scenario. Transport of used windows is directed to a waste treatment facility.

C3 – Takes into account the environmental impact during the treatment of waste windows for flat roofs at the waste treatment facility. Data is collected based on a developed scenario. Module C3 considers the environmental impact of energy consumption..

C4 – describes the process of disposal/storage of waste generated from the processing of used flat roof windows. The benefits of reusing glass and scrap metal are covered in Module D..

D – describes the benefits of reusing waste generated from the processing of flat roof windows in module C3. Recycling of glass and metal is included, as well as the energy (heat) generated from the incineration of waste plastics in a thermal waste disposal plant. The energy stream from incineration was interpreted as energy exported in module D..

Cut-off criteria

99% of all mass flows involved in the production process were taken into account.
All the energy used in the process has been taken into account in the EPD.

Generic data	The main source of general and auxiliary data is the EcoInvent 3.8 database and manufacturer's reports.
Allocation	The products covered by the environmental declaration are manufactured at the plant in Nowy Sącz. All data provided by the manufacturer were related to the declared unit (DU) of the product – **1 m²** (1 square meter) of flat roof windows manucatured by FAKRO PP Sp. z.o.o. in Nowy Sącz.

4. LCA: SCENARIOS AND ADDITIONAL TECHNICAL DATA

For the life cycle analysis of the products covered by the "Cradle to gate with options" environmental declaration, scenarios were developed for modules C1-C4 and D:

C1 - It is assumed that manual dismantling of the window is possible and that the possible use of electro-tools has a minimal impact on the impact category values and is negligible.

C2 – Transport of used windows is directed to a waste treatment facility.
The following assumptions have been made:

- 100% of the mass of used windows is diverted to a waste treatment facility,
- Transport is carried out using self-dumping trucks transport is carried out using dump trucks with a payload of 7.5 - 16 tonnes, meeting EURO 5 emission standards,
- Material is transported to a waste treatment site located 100 km from the demolition site.

C3 - The scenario envisages the process of treating used windows by manually separating the window components from each other and mechanically processing (shredding) some of the fractions resulting from separation. Firstly, insulating glass units, plastic components and steel frames, aluminium components and znal ferrules are separated. Glass and plastics are mechanically shredded, while steel scrap is not subjected to additional treatment and is sent for recycling. Glass waste is handled similarly - it is assumed that broken glass is recycled as container glass. The benefits of using these secondary materials are included in Module D. Plastic waste is used energetically (in waste incinerators). The energy consumption per kilogram of window waste is estimated to be about 0.03 kWh/kg electricity and about 0.5 MJ/kg heat energy from fuel combustion.

C4 - The utilization of glass cullet is assumed to be 70%, scrap (steel, znal) - 90%, while 100% of plastic waste is disposed of in a waste incinerator. The remaining waste is landfilled.

D – Recycling of glass and metal is included, as well as the energy (heat) generated by incineration of waste plastics in a thermal waste treatment plant. The amount of energy was determined based on the amount of material recycled, the calorific value and the efficiency of the heat recovery process, which was assumed to be 32%.

5. LCA: RESULTS

The table below shows the LCA modules included in the calculation of the environmental impact categories for the products covered by the declaration.

SYSTEM BOUNDARIES (X – MODULE INCLUDED IN LCA, MND – MODULE NOT DECLARED, INA – INDICATOR NOT ASSESSED)																
Product stage			**Construction process stage**		**Use stage**							**End-of-life stage**				**Benefits and loads beyond the system boundary**
Raw material supply	Transport	Production	Transport to the construction site	Construction proces	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction	Transport	Waste processing	Disposal	Reuse-recovery-recycling potentiial
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	**X**	**X**	**MND**	**MND**	**MND**	**MND**	**MND**	**MND**	**MND**	**MND**	**MND**	**X**	**X**	**X**	**X**	**X**

The following tables present the results of the LCA analysis for flat roof windows with one, two and three-chamber glazing units. Explanations of the abbreviations used to describe the impact categories are given below:

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
ADP-minerals&metals	Abiotic depletion potential for nonfossil resources
ADP-fossil	Abiotic depletion potential for fossil resources
WDP	Water (user) deprivation potential

PM	Potential incidence of disease due to PM emissions
IRP	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 (non-cancerogenic)
SQP	Potential soil quality index
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 nonrenewable 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

FLAT ROOF WINDOWS WITH SINGLE-CHAMBER GLAZING UNITS

CORE ENVIRONMENTAL IMPACT INDICATORS: 1 m² of flat roof windows with single-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

	Life Cycle Stage								
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-total	kg CO_2 eq.	2,32E+02	5,63E+00	-1,47E+01	0,00E+00	1,38E+00	2,95E+00	3,20E-02	-8,70E+01
GWP-fossil	kg CO_2 eq.	2,31E+02	5,61E+00	1,92E+01	0,00E+00	1,38E+00	2,94E+00	3,19E-02	-8,69E+01
GWP-biogenic	kg CO_2 eq.	9,19E-01	9,95E-03	-3,40E+01	0,00E+00	1,26E-03	6,52E-03	1,35E-04	-1,14E-02
GWP-luluc	kg CO_2 eq.	1,82E-01	3,22E-03	6,76E-02	0,00E+00	6,53E-04	4,95E-04	7,17E-06	-1,86E-03
ODP	kg CFC11 eq.	4,06E-05	1,21E-06	1,68E-06	0,00E+00	3,12E-07	3,28E-07	1,58E-08	-5,91E-07
AP	mol H+ eq.	1,33E+00	2,55E-02	1,02E-01	0,00E+00	3,91E-03	2,58E-02	3,13E-04	-2,27E-02
EP-freshwater	kg PO_4 eq.	1,16E-01	6,82E-04	5,66E-03	0,00E+00	1,04E-04	1,90E-03	1,82E-06	-5,41E-04
EP-marine	kg N eq.	2,27E-01	7,08E-03	3,06E-02	0,00E+00	7,64E-04	8,19E-03	1,18E-04	-1,14E-02
EP-terrestrial	mol N eq.	2,46E+00	7,77E-02	2,75E-01	0,00E+00	8,32E-03	8,60E-02	1,30E-03	-1,02E-01
POCP	kg NMVOC eq.	7,49E-01	2,61E-02	1,09E-01	0,00E+00	3,19E-03	2,37E-02	3,71E-04	-2,60E-02
ADP-minerals & metals	kg Sb eq.	2,62E-02	6,27E-05	7,93E-05	0,00E+00	6,33E-06	1,42E-06	6,22E-08	-1,54E-05
ADP-fossil	MJ	3,57E+03	8,36E+01	3,46E+02	0,00E+00	2,07E+01	3,62E+01	1,03E+00	-1,83E+01
WDP	m^3 world eq. deprived	1,45E+02	3,58E-01	1,11E+01	0,00E+00	6,86E-02	2,34E-01	3,26E-03	-1,04E+00

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS: 1 m² of flat roof windows with single-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

	Life Cycle Stage								
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
PM	Disease incidency	1,64E-05	5,29E-07	1,44E-06	0,00E+00	9,44E-08	4,19E-07	6,92E-09	-1,59E-07
IRP	kBq U235 eq.	1,86E+01	4,98E-01	1,66E+00	0,00E+00	1,10E-01	1,32E-01	4,96E-03	-1,51E-01
ETP-fw	CTUe	1,16E-01	6,82E-04	5,66E-03	0,00E+00	1,04E-04	1,90E-03	1,82E-06	-5,41E-04
HTP-c	CTUh	1,96E-07	6,68E-09	5,32E-08	0,00E+00	6,10E-10	9,14E-10	1,30E-11	-1,74E-08
HTP-nc	CTUh	6,82E-06	9,28E-08	2,51E-07	0,00E+00	1,63E-08	3,01E-08	2,70E-10	-1,66E-07
SQP	-	7,02E+02	4,39E+01	3,23E+03	0,00E+00	1,22E+01	5,58E+00	2,29E+00	-6,14E+00

PARAMETERS DESCRIBING RESOURCE USE: 1 m² of flat roof windows with single-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

	Life Cycle Stage								
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	1,99E+02	1,97E+00	6,09E+02	0,00E+00	3,51E-01	1,32E+00	2,10E-02	-1,69E+00
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	1,99E+02	1,97E+00	6,09E+02	0,00E+00	3,51E-01	1,32E+00	2,10E-02	-1,69E+00
PEN-RE	MJ	2,58E+03	7,67E+01	2,36E+02	0,00E+00	2,68E+01	4,66E+01	2,39E+01	-6,92E+00
RE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

PENRT	MJ	2,58E+03	7,67E+01	2,36E+02	0,00E+00	2,68E+01	4,66E+01	2,39E+01	-6,92E+00
SM	kg	0,00E+00	0,00E+00	1,00E+00	0,00E+00	0,00E+00	4,14E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,11E+02
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	2,44E+00	2,84E-02	4,46E-01	0,00E+00	4,14E-03	1,21E+00	3,58E-05	-1,04E-02

ENVIRONMENTAL INFORMATION DESCRIBING WASTE AND OUTPUT FLOWS: 1 m^2 of flat roof windows with single-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

	Life Cycle Stage								
Indicator	**Unit (expressed per DU)**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste	kg	WN	WN	7,77E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-hazardous waste	kg	WN	WN	2,32E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Radioactive waste	kg	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Components for re-use	kg	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	WN	WN	1,00E-03	0,00E+00	0,00E+00	4,14E+01	0,00E+00	0,00E+00
Materials for energy recovery	kg	WN	WN	3,70E+01	0,00E+00	0,00E+00	0,00E+01	0,00E+00	0,00E+00
Exported energy	MJ/energy carrier	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,11E+02

CARBON ORGANIC	
Contents organic carbon in product (kg C_{org})	**0,00E+00**
Contents organic carbon in packaging (kg C_{org})	**2,79E+00**

FLAT ROOF WINDOWS WITH DOUBLE-CHAMBER GLAZING UNITS

CORE ENVIRONMENTAL IMPACT INDICATORS: 1 m² of flat roof windows with double-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

		Life Cycle Stage							
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-total	kg CO_2 eq.	1,70E+02	7,20E+00	-1,92E+01	0,00E+00	1,54E+00	3,75E+00	5,42E-02	-5,81E+01
GWP-fossil	kg CO_2 eq.	1,69E+02	7,19E+00	1,42E+01	0,00E+00	1,54E+00	3,74E+00	5,39E-02	-5,81E+01
GWP-biogenic	kg CO_2 eq.	1,03E+00	1,13E-02	-3,35E+01	0,00E+00	1,40E-03	8,30E-03	2,28E-04	-7,82E-03
GWP-luluc	kg CO_2 eq.	1,92E-01	3,82E-03	5,80E-02	0,00E+00	7,28E-04	6,30E-04	1,21E-05	-1,33E-03
ODP	kg CFC11 eq.	4,29E-05	1,58E-06	1,45E-06	0,00E+00	3,47E-07	4,18E-07	2,67E-08	-4,07E-07
AP	mol H+ eq.	1,25E+00	3,00E-02	8,14E-02	0,00E+00	4,36E-03	3,28E-02	5,29E-04	-1,56E-02
EP-freshwater	kg PO_4 eq.	1,12E-01	7,80E-04	4,61E-03	0,00E+00	1,16E-04	2,42E-03	3,07E-06	-3,76E-04
EP-marine	kg N eq.	2,13E-01	7,98E-03	2,48E-02	0,00E+00	8,51E-04	1,04E-02	2,00E-04	-7,74E-03
EP-terrestrial	mol N eq.	2,35E+00	8,75E-02	2,30E-01	0,00E+00	9,26E-03	1,09E-01	2,19E-03	-6,95E-02
POCP	kg NMVOC eq.	6,64E-01	2,99E-02	8,47E-02	0,00E+00	3,55E-03	3,02E-02	6,28E-04	-1,78E-02
ADP-minerals & metals	kg Sb eq.	2,45E-02	6,77E-05	7,17E-05	0,00E+00	7,04E-06	1,80E-06	1,05E-07	-1,07E-05
ADP-fossil	MJ	2,85E+03	1,07E+02	2,49E+02	0,00E+00	2,30E+01	4,60E+01	1,75E+00	-1,33E+01
WDP	m^3 world eq. deprived	1,29E+02	4,29E-01	8,18E+00	0,00E+00	7,64E-02	2,98E-01	5,52E-03	-6,75E-01

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS: 1 m² of flat roof windows with double-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

		Life Cycle Stage							
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
PM	Disease incidency	1,08E-05	6,59E-07	1,19E-06	0,00E+00	1,05E-07	5,33E-07	1,17E-08	-1,17E-07
IRP	kBq U235 eq.	1,99E+01	6,20E-01	1,36E+00	0,00E+00	1,22E-01	1,68E-01	8,40E-03	-1,08E-01
ETP-fw	CTUe	1,12E-01	7,80E-04	4,61E-03	0,00E+00	1,16E-04	2,42E-03	3,07E-06	-3,76E-04
HTP-c	CTUh	1,79E-07	7,24E-09	5,17E-08	0,00E+00	6,79E-10	1,16E-09	2,21E-11	-1,17E-08
HTP-nc	CTUh	5,21E-06	1,12E-07	2,24E-07	0,00E+00	1,82E-08	3,83E-08	4,58E-10	-1,13E-07
SQP	-	7,86E+02	6,11E+01	3,16E+03	0,00E+00	1,36E+01	7,09E+00	3,88E+00	-5,42E+00

PARAMETERS DESCRIBING RESOURCE USE: 1 m² of flat roof windows with double-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

		Life Cycle Stage							
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	2,09E+02	2,29E+00	5,94E+02	0,00E+00	3,91E-01	1,68E+00	3,56E-02	-2,28E+00
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	2,09E+02	2,29E+00	5,94E+02	0,00E+00	3,91E-01	1,68E+00	3,56E-02	-2,28E+00
PEN-RE	MJ	1,99E+03	3,72E+01	1,81E+02	0,00E+00	2,36E+01	4,94E+01	2,05E+01	-4,98E+00
RE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

PENRT	MJ	1,99E+03	3,72E+01	1,81E+02	0,00E+00	2,36E+01	4,94E+01	2,05E+01	-4,98E+00
SM	kg	0,00E+00	0,00E+00	1,00E+00	0,00E+00	0,00E+00	6,00E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,62E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	2,54E+00	3,20E-02	3,70E-01	0,00E+00	3,55E-03	1,17E+00	6,06E-05	-7,21E-03
ENVIRONMENTAL INFORMATION DESCRIBING WASTE AND OUTPUT FLOWS: 1 m^2 of flat roof windows with double-chamber glazing units manucatured in FAKRO PP Sp. z o.o.									
	Life Cycle Stage								
Indicator	**Unit (expressed per DU)**	WN	WN	1,90E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Hazardous waste	kg	WN	WN	5,58E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-hazardous waste	kg	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Radioactive waste	kg	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Components for re-use	kg	WN	WN	1,00E+00	0,00E+00	0,00E+00	6,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	WN	WN	2,47E+01	0,00E+00	0,00E+00	0,00E+01	0,00E+00	0,00E+00
Materials for energy recovery	kg	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,62E+00
Exported energy	MJ/energy carrier	WN	WN	1,90E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

CARBON ORGANIC	
Contents organic carbon in product (kg C_{org})	**0,00E+00**
Contents organic carbon in packaging (kg C_{org})	**2,18E-00**

FLAT ROOF WINDOWS WITH TRIPLE-CHAMBER GLAZING UNITS

CORE ENVIRONMENTAL IMPACT INDICATORS: 1 m² of flat roof windows with triple-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

		Life Cycle Stage							
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-total	kg CO_2 eq.	1,79E+02	9,44E+00	-1,94E+01	0,00E+00	2,08E+00	5,14E+00	7,85E-02	-7,06E+01
GWP-fossil	kg CO_2 eq.	1,77E+02	9,42E+00	1,41E+01	0,00E+00	2,08E+00	5,13E+00	7,81E-02	-7,06E+01
GWP-biogenic	kg CO_2 eq.	1,12E+00	1,46E-02	-3,35E+01	0,00E+00	1,90E-03	1,14E-02	3,30E-04	-9,54E-03
GWP-luluc	kg CO_2 eq.	1,96E-01	4,96E-03	5,79E-02	0,00E+00	9,84E-04	8,64E-04	1,76E-05	-1,61E-03
ODP	kg CFC11 eq.	4,39E-05	2,08E-06	1,45E-06	0,00E+00	4,69E-07	5,73E-07	3,87E-08	-4,95E-07
AP	mol H+ eq.	1,34E+00	3,89E-02	8,08E-02	0,00E+00	5,90E-03	4,50E-02	7,66E-04	-1,89E-02
EP-freshwater	kg PO_4 eq.	1,13E-01	1,01E-03	4,59E-03	0,00E+00	1,57E-04	3,31E-03	4,45E-06	-4,57E-04
EP-marine	kg N eq.	2,27E-01	1,03E-02	2,47E-02	0,00E+00	1,15E-03	1,43E-02	2,89E-04	-9,41E-03
EP-terrestrial	mol N eq.	2,52E+00	1,13E-01	2,29E-01	0,00E+00	1,25E-02	1,50E-01	3,18E-03	-8,45E-02
POCP	kg NMVOC eq.	7,07E-01	3,87E-02	8,39E-02	0,00E+00	4,81E-03	4,14E-02	9,09E-04	-2,16E-02
ADP-minerals & metals	kg Sb eq.	2,44E-02	8,70E-05	7,16E-05	0,00E+00	9,53E-06	2,47E-06	1,52E-07	-1,30E-05
ADP-fossil	MJ	2,95E+03	1,41E+02	2,46E+02	0,00E+00	3,12E+01	6,31E+01	2,53E+00	-1,62E+01
WDP	m^3 world eq. deprived	1,32E+02	5,59E-01	8,08E+00	0,00E+00	1,03E-01	4,09E-01	7,99E-03	-8,18E-01

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS: 1 m² of flat roof windows with triple-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

		Life Cycle Stage							
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
PM	Disease incidency	1,17E-05	8,62E-07	1,18E-06	0,00E+00	1,42E-07	7,31E-07	1,70E-08	-1,42E-07
IRP	kBq U235 eq.	2,04E+01	8,11E-01	1,35E+00	0,00E+00	1,66E-01	2,30E-01	1,22E-02	-1,31E-01
ETP-fw	CTUe	1,13E-01	1,01E-03	4,59E-03	0,00E+00	1,57E-04	3,31E-03	4,45E-06	-4,57E-04
HTP-c	CTUh	1,80E-07	9,31E-09	5,16E-08	0,00E+00	9,18E-10	1,59E-09	3,20E-11	-1,43E-08
HTP-nc	CTUh	5,24E-06	1,45E-07	2,24E-07	0,00E+00	2,46E-08	5,26E-08	6,62E-10	-1,37E-07
SQP	-	8,22E+02	8,09E+01	3,16E+03	0,00E+00	1,84E+01	9,73E+00	5,62E+00	-6,64E+00

PARAMETERS DESCRIBING RESOURCE USE: 1 m² of flat roof windows with triple-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

		Life Cycle Stage							
Indicator	**Unit**	**A1**	**A2**	**A3**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	2,13E+02	2,97E+00	5,94E+02	0,00E+00	5,29E-01	2,30E+00	5,15E-02	-1,43E+00
PERM	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	2,13E+02	2,97E+00	5,94E+02	0,00E+00	5,29E-01	2,30E+00	5,15E-02	-1,43E+00
PEN-RE	MJ	2,05E+03	4,32E+01	1,80E+02	0,00E+00	2,56E+01	6,10E+01	2,15E+01	-6,06E+00
RE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

PENRT	MJ	2,05E+03	4,32E+01	1,80E+02	0,00E+00	2,56E+01	6,10E+01	2,15E+01	-6,06E+00
SM	kg	0,00E+00	0,00E+00	1,00E+00	0,00E+00	0,00E+00	7,41E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,97E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	2,60E-00	4,13E-02	3,69E-01	0,00E+00	4,80E-03	1,60E-00	8,77E-05	-8,76E-03

ENVIRONMENTAL INFORMATION DESCRIBING WASTE AND OUTPUT FLOWS: 1 m^2 of flat roof windows with triple-chamber glazing units manucatured in FAKRO PP Sp. z o.o.

	Life Cycle Stage								
Indicator	**Unit (expressed per DU)**	WN	WN	1,90E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Hazardous waste	kg	WN	WN	6,64E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-hazardous waste	kg	WN	WN	1,98E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Radioactive waste	kg	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Components for re-use	kg	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	WN	WN	1,00E+00	0,00E+00	0,00E+00	7,41E+00	0,00E+00	0,00E+00
Materials for energy recovery	kg	WN	WN	3,00E+01	0,00E+00	0,00E+00	0,00E+01	0,00E+00	0,00E+00
Exported energy	MJ/energy carrier	WN	WN	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,97E+00

CARBON ORGANIC	
Contents organic carbon in product (kg C_{org})	**0,00E+00**
Contents organic carbon in packaging (kg C_{org})	**2,18E+00**

6. INTERPRETATION OF LCA

Figures 2, 3 and 4 show contributions of the each life cycl module to the basic impact categories for flat roof windows *with one, two and three-chamber glazing units*.

Fig. 2 Shares of life cycle modules on main categories of influence – Fakro – flat roof windows with single-chamber

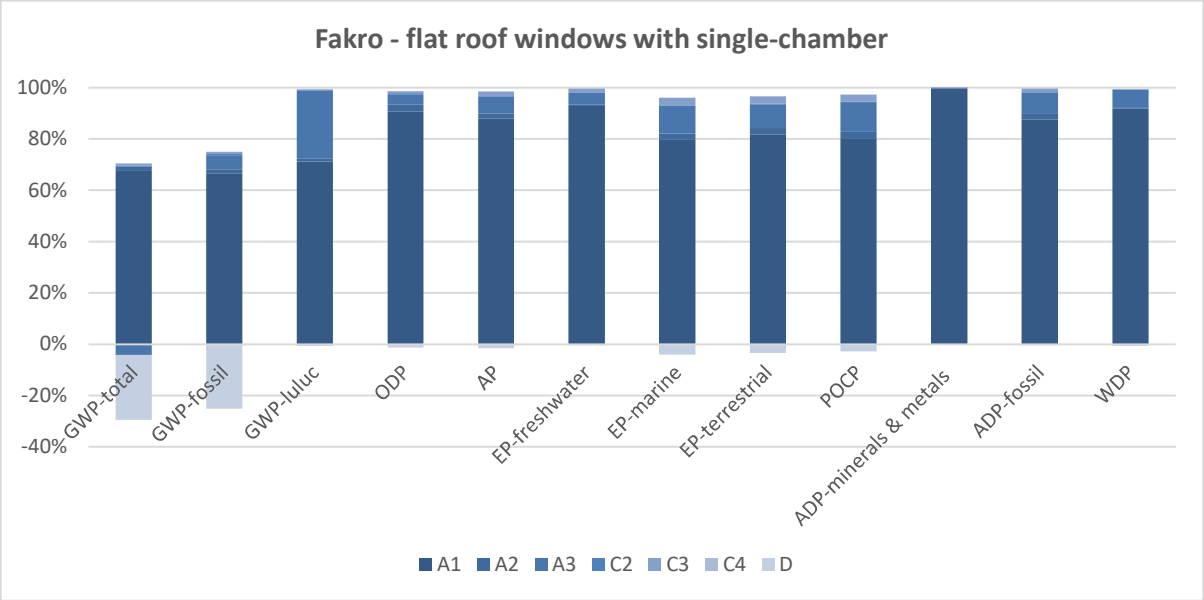


Fig. 3 Shares of life cycle modules on main categories of influence – Fakro – flat roof windows with double-chamber

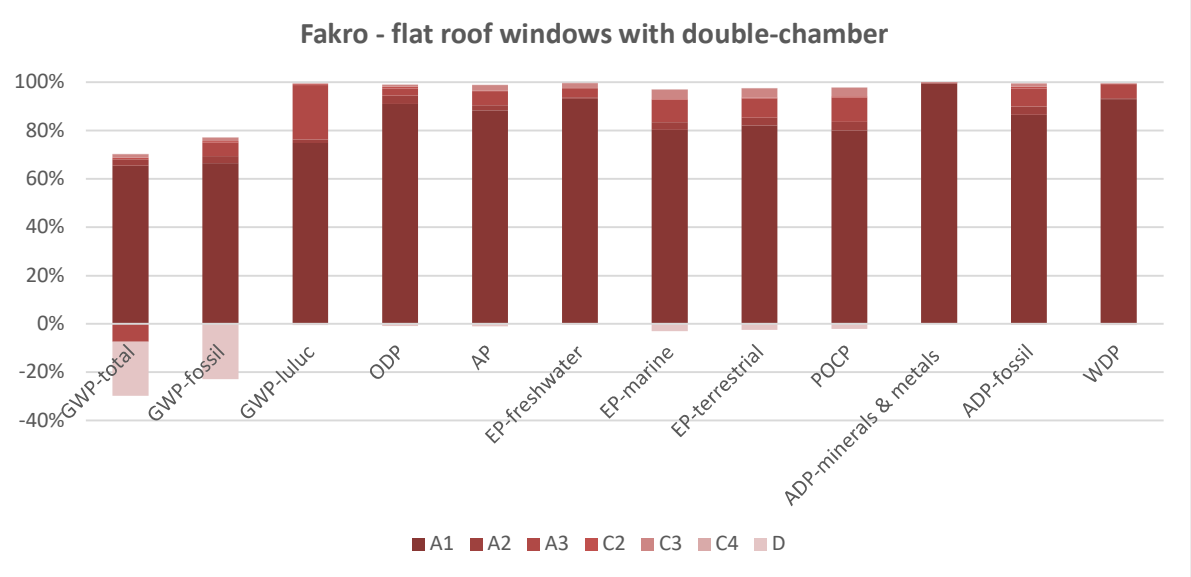
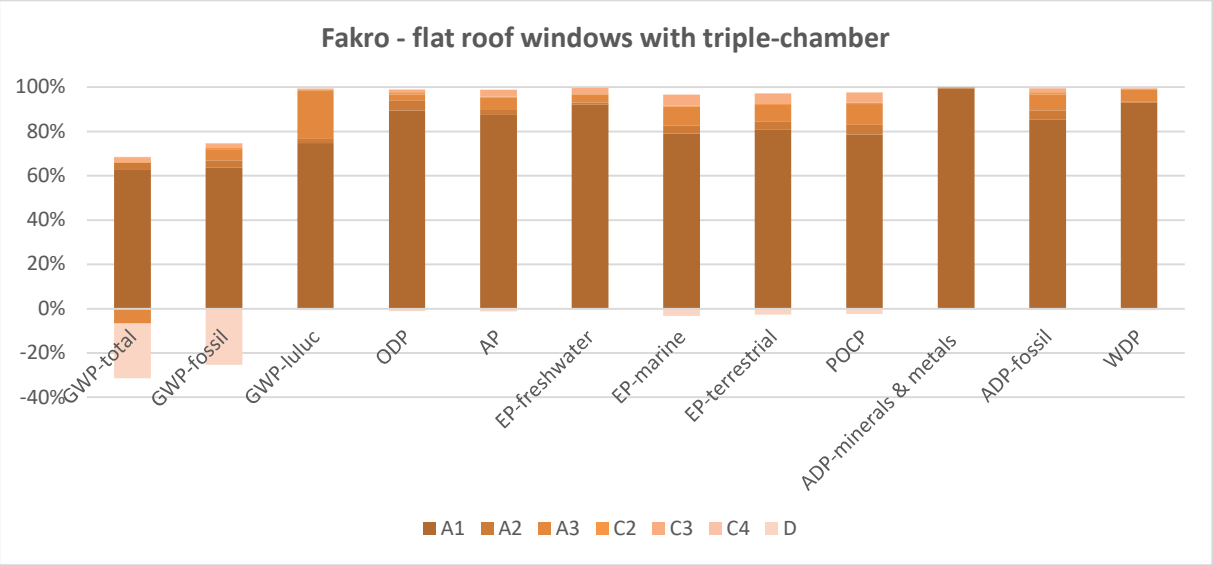


Fig. 4 Shares of life cycle modules on main categories of influence – Fakro – flat roof windows with triple-chamber



As a result of the LCA analysis carried out in accordance with the requirements and assumptions concerning the system boundaries and cut-off criteria for the product group (flat roof windows) manufactured by FAKRO PP SP. z o.o. the following conclusions were made:

- The LCA analysis proved that the greatest influence on the value of the environmental impact indicators on the environment is that of the processes involved in obtaining raw materials and intermediate products (A1). They account for up to approximately 80% to nearly 100% of the total value of the impact category. Different processes have a varying impact on the individual impact categories..
- The high values of the impact categories for these processes are due to the fact, that the materials resulting from these processes have the highest mass share per declared unit. In addition, these processes are energy-intensive, requiring the provision of large amounts of heat and electricity.
- The impact of transport to the plant (A2) on the impact categories accounts for up to 7% of the total impact in the main categories.

- Due to the nature of the production process, which mainly consists of material processing and assembly of finished parts, the values of the main impact categories in module A3 amount in the analysed product groups to up to 10%.
- Transport to the waste treatment facility (C2) has a very low impact on the overall impact category value compared to the other modules. Waste treatment processes (C3) account for a maximum of to 4% in the main impact categories. This depends on the amount of material to be processed and the technology at the waste treatment facility. Transport to the waste treatment plant (C2) has a very small impact on the overall value of the impact category compared to the other modules.
- The impact related to waste treatment/landfill (C4) is significant - accounting for up to a maximum of approximately 24% in the main impact categories. This is due to the way in which the plastic waste generated from the processing of roof windows is handled. The incineration of plastics results in the release of significant amounts of substances negatively affecting the quality of the environment and impact category values.
- An analysis of the potential for material reuse (D) showed that the secondary use of roof window waste reduces the negative impact on environmental indicators. The included thermal energy gained from the thermal conversion of waste plastics makes it possible to compensate to some extent for the negative environmental impact of the process itself.
- The above conclusions show that sensibly managed waste management makes it possible to significantly reduce the environmental impact of the product in the end-of-life phase.

7. LITERATURE

- ✓ PN-EN ISO 14025: 2014-04, Environmental labels and declarations - Type III environmental declarations - Rules and procedures.
- ✓ PN-EN 15804 + A2: 2020, Sustainability of construction works - Environmental product declarations - Basic rules for categorizing construction products.
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