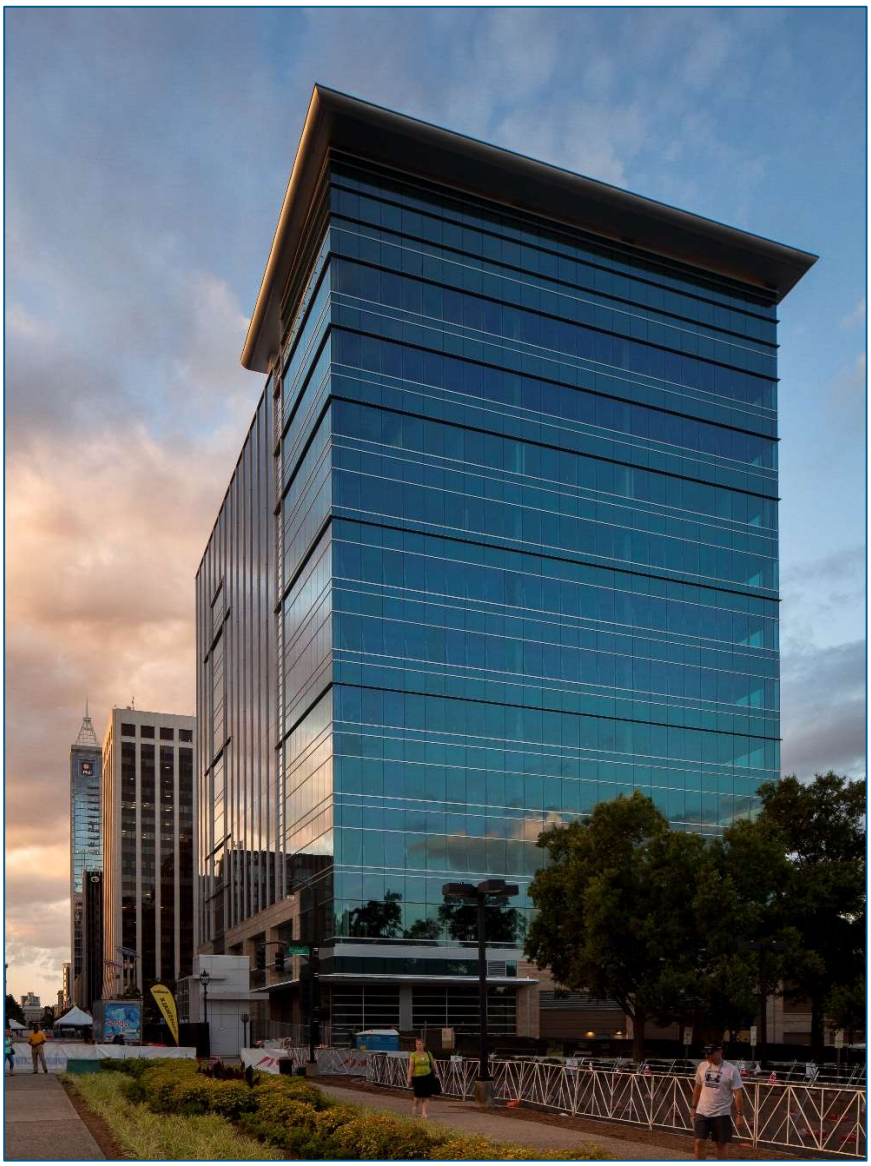
Window Wall Systems



Environmental Product Declaration

Conducted in accordance with ISO 14025 and ISO 21930

EPDs are not intended to make comparisons with other products due to varying background data in LCA softwares and/or varying Program Operator rules or Product Category Rules. The EPD and PCR process are informational only and do not warrant performance.

EPD SUMMARY

PROGRAM OPERATOR	ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA, 19428. https://www.astm.org/
DECLARATION NUMBER	498
DATE OF ISSUE	12 June 2023
VALID UNTIL	11 June 2028
EPD HOLDER	EFCO, LLC, a part of Apogee Enterprises, Inc. 1000 County Rd., Monett, MO 65708 https://efcocorp.com/ +1 800.221.4169
DECLARED PRODUCT & UNIT	EFCO Window Wall System – per 1 m^2
MARKET OF APPLICABILITY	North America, intended for B2B communication
EPD TYPE	Product-specific, cradle-to-gate scope
LCA SOFTWARE	SimaPro 9.4
PCR SUBCATEGORY	Earthsure. "Cradle to Gate Window Product Category Rule." September 10, 2015, v 1.02, Extended per PCR ext 2022-112, valid through September 30, 2023. Reviewed by: Tom Gloria, LCACP, Industrial Ecology Consultants, Chair; Adolf Merl, ThinkStep GmbH; Philip Moser, Simpson Gumpertz & Heger Inc.

The declaration and LCA data were independently verified in accordance with ISO 14044:2006, ISO 14025:2006 and ISO 21930:2017. Verification was performed: ___ Internally _X_ Externally	
Life cycle assessment practitioner:	Anne Landfield Greig, LCA CP, Four Elements Consulting, LLC https://www.fourelementsllc.com anne@fourelementsllc.com
Third-party verifier:	Lindita Bushi, Ph.D., Athena Sustainable Materials Institute

EFCO, LLC

EFCO, LLC is a leading manufacturer of architectural aluminum windows, curtain walls, storefronts, and entrance systems for commercial architectural applications. Headquartered in Monett, Missouri, our mission is to be the most trusted supplier in commercial architecture. We seek to provide customers with the highest quality, innovation, value, and service.

EFCO is a part of Apogee Enterprises, Inc., a leading provider of architectural products and services for enclosing buildings and glazing products for framing art.

Product Description

Used primarily for low to mid rise multi-family and mixed-use buildings, window wall products provide the appearance of a traditional curtain wall system, but at a lower price point. Anchored at the head and sill at each floor and installed into the subframe, EFCO's window wall products can be installed from the building's interior.

EFCO window wall systems include the following product lines: Xtherm, Xtherm - XLT, 645X, 900RW, 600R. These products fall under industry codes CSI: 08 51 00 (metal windows) and UNSPSC: 30171613 (window walls).

Life Cycle Assessment Overview

A cradle-to-grave Life Cycle Assessment (LCA) was completed on EFCO window wall systems in accordance with ISO 14040 / ISO 14044, and the study was reviewed for conformance with ISO 14044, ISO 21930:2017, ASTM program operator rules, and the PCR subcategory. The product assessed was based on 2022 data from EFCO’s manufacturing facilities in Missouri and Wisconsin.

System Boundaries

The LCA evaluated the cradle to gate of the window wall system. This includes: raw material extraction and processing (A1), transportation of the materials to fabrication plants (A2), and manufacturing or fabrication (A3). This is depicted below in the context of the construction works life cycle (adapted from 21930:2017 Fig 1).

Table 1 EPD System Boundary Modules

A1-A3			A4-A5		B1-B7					C1-C4				D
PRODUCTION Stage			CONSTRUC-TION Stage		USE Stage					END-OF-LIFE Stage				Benefits & Loads
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Product Use	Maintenance	Repair	Full replacement	Refurbishment	Deconstruction / Demolition	Transport to waste processing or disposal	Waste processing	Disposal of waste	Reuse, recovery, recycling potential
Mandatory			Scenarios		Scenarios B6 Operational energy use scenario B7 Operational water use scenario					Scenarios				Scenario

Figure 1 presents the A1-A3 stages as they pertain to the EFCO window wall system and additionally provides aspects of the life cycle that are excluded from the study.

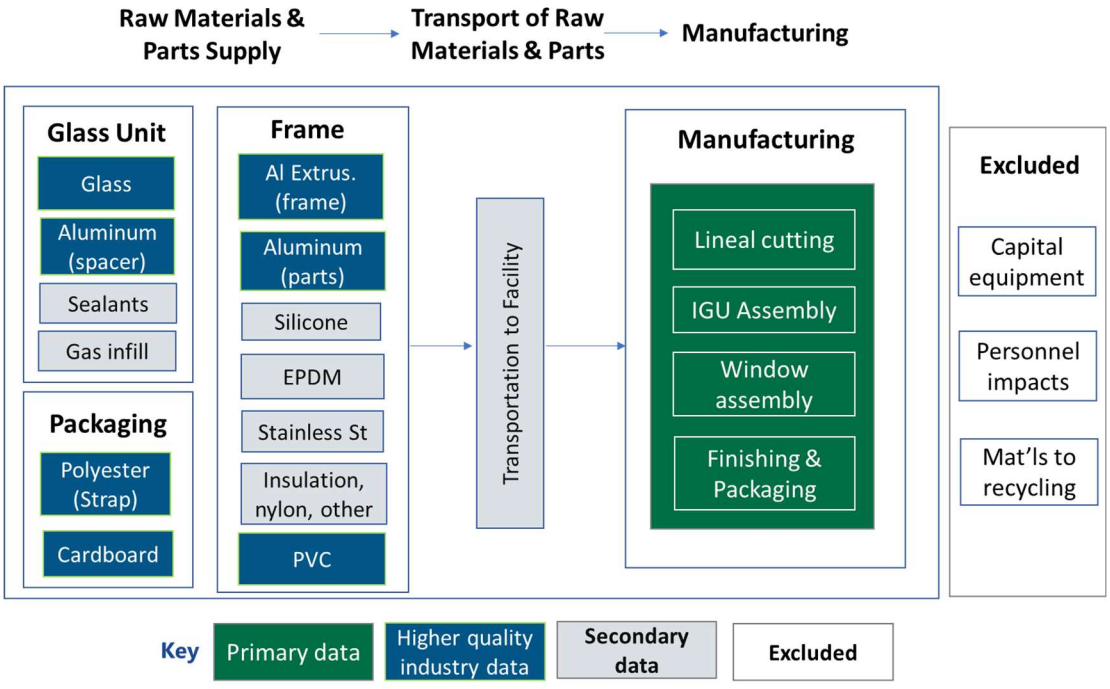


Figure 1 EFCO Window Wall System Boundary and Data

Declared Unit

The declared unit is one square meter (1 m^2) of the EFCO window wall produced at manufacturing plants in MO and WI. A functional unit is not reported since the product system boundaries are cradle-to-gate, and no use phase over a reference service life has been modeled.

A1 Raw Material Extraction and Processing

Main Component	Materials	% of Total
Frame	Aluminum & polyamide	42.46%
	Rubber and silicone	1.64%
	Steel parts	0.08%
	Other	0.69%
Glass Unit	Glass	50.67%
	Aluminum	4.33%
	Sealants and other	0.13%

Module A1 accounts for the extraction of materials and production of framing, insulated glass units (IGUs), and packaging parts and components. Table 2 presents the bill of materials as a percent of the total product.

Table 2 Bill of Materials

A2 Transportation to Manufacturing

Module A2 accounts for transportation of raw materials to EFCO facilities. The distances of the parts and materials by heavy duty diesel truck were based on supplier data provided by EFCO.

A3 Manufacturing

Module A3 includes assembly of the window wall at the Monett, MO and Wausau, WI facilities. 2022 energy use, emissions, and waste management were included in the model. The SPP North and MRO East electricity grids mixes were used for the Missouri and Wisconsin production plants, respectively.

Cut-off Criteria

The cut-off goal of at least 95% of all mass and energy used in the system was exceeded since all materials and energy involved in the materials systems were included.

Allocation

Data was provided on a whole-facility basis. Allocation of manufacturing energy and other facility aspects was made on a total mass basis, based on the production volume fabricated at each facility.

Software and Data Used

The SimaPro LCA software was used to model the window wall system. Data came from sources appropriate for the EFCO window wall system, with intentional choices made for datasets having the highest quality data. Secondary data came from several databases,

including Industry 2.0 for industry-average high quality LCA data, DATASMART for North American energy, transportation, parts and materials, and ecoinvent for energy, parts and materials not included in DATASMART.

Data Quality

The data applied to this study are representative of the current EFCO window wall system. EFCO's facilities supplied 2022 process data. Energy and transportation data are based on the high 2010's, and production data for materials are based on mid 2010's through 2022. Data for energy, transportation, materials and processes are based on a combination of North American and European sources which, where possible, were customized to reflect North American conditions. Technological coverage for the upstream materials and processes is generally industry average, and in some instances, it is typical technology.

Results and Contribution Analysis

The Life Cycle Impact Assessment (LCIA) results were calculated using Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI) v.2.1, a North American impact assessment methodology. Global Warming Potential is based on IPCC 6th Assessment. Abiotic Depletion Potential for fossil fuels is based on CML's baseline methodology. LCIA results in

Table *3* and

Table 4 are presented for the cradle to gate totals, showing A1, A2, and A3 as absolute values and as percentages, respectively. In the third table, the Life Cycle Inventory (LCI), or non-LCIA inventory metrics, are calculated in accordance with the ACLCA (2019) Guidance.

Table 3 Impact Assessment Results – absolute values

Per 1 m^2 Declared Unit			Materials production	Transport to facility	Manuf-acturing
Impact Categories - LCIA	**Unit**	**TOTAL**	**A1**	**A2**	**A3**
Global warming potential	kg CO2-e	180.39	163.80	3.92	12.67
Acidification potential	kg SO2-e	1.10	1.00	0.02	0.08
Eutrophication potential	kg N-e	0.44	0.43	0.00	0.01
Smog creation potential	kg O3-e	11.35	9.94	0.62	0.78
Ozone depletion potential	kg CFC11-e	6.98 E-06	6.93 E-06	6.88 E-09	4.26 E-08
ADP fossil	MJ (LHV)	2031.86	1818.55	48.91	164.39
Total energy (used as fuel)	MJ (LHV)	2482.75	2252.71	49.74	180.30

Table 4 Impact Assessment Results – percentages

Per 1 m^2 Declared Unit

			Materials production	Transport to facility	Manuf-acturing
Impact Categories – LCIA	**Unit**	**TOTAL**	**A1**	**A2**	**A3**
Global warming potential	kg CO2-e	180.39	90.81%	2.17%	7.02%
Acidification potential	kg SO2-e	1.10	90.93%	1.96%	7.11%
Eutrophication potential	kg N-e	0.44	98.31%	0.47%	1.22%
Smog creation potential	kg O3-e	11.35	87.62%	5.49%	6.89%
Ozone depletion potential	kg CFC11-e	6.98 E-06	99.29%	0.10%	0.61%
ADP fossil	MJ (LHV)	2031.86	89.50%	2.41%	8.09%
Total energy (used as fuel)	MJ (LHV)	2482.75	90.73%	2.00%	7.26%

Note: numbers may not add to 100% due to rounding. 0% implies less than 0.1%.

Table 5 Inventory Results

Per 1 m^2 Declared Unit

			Materials production	Transport to facility	Manuf-acturing
Additional Categories – LCI	**Unit**	**TOTAL**	**A1**	**A2**	**A3**
Resource Use: Energy					
Non-renewable primary energy – fuel	MJ (LHV)	2226.32	2005.76	49.63	170.94
Non-renewable primary engy. res. - raw materials	MJ (LHV)	16.90	16.90	N/A	0.00
Renewable primary energy – fuel	MJ (LHV)	256.43	246.96	0.11	9.36
Renewable primary engy. res. - raw materials	MJ (LHV)	1.01 E-08	1.01 E-08	N/A	0.00
Resource use: Materials					
Use of secondary materials	Kg	13.03	13.03	N/A	0.00
Use of renewable secondary fuels	MJ (LHV)	0.00	N/A	N/A	0.00
Use of non-renewable secondary fuels	MJ (LHV)	0.00	N/A	N/A	0.00
Use of recovered energy	MJ (LHV)	0.00	N/A	N/A	0.00
Use of net fresh water (inputs minus outputs)	m^3	1.24	1.23	4.34 E-04	6.94 E-03
Waste categories					
Non-hazardous waste disposed	Kg	0.19	N/A	N/A	0.19
Hazardous waste disposed	Kg	0.00	N/A	N/A	0.00
High-level radioactive waste	Kg	8.16 E-04	7.94 E-04	2.09 E-06	1.91 E-05
Intermediate- & low-level radioactive waste	Kg	2.21 E-03	2.16 E-03	4.66 E-06	4.25 E-05
Other output flows					

Components for reuse	kg	0.11	0.11	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00	0.00
Materials for energy recovery	kg	0.00	0.00	0.00	0.00
Exported energy	MJ (LHV)	0.00	0.00	0.00	0.00

Additional Environmental Information

At end of life, approximately 96% of the total mass of the product may be recycled. This includes the aluminum framing and glass plus the additional aluminum and steel components in the product.

No substances in the EFCO window wall system are on the Candidate List of Substances of Very High Concern. The are no materials present in over 0.1% by mass of the product that are hazardous to human health and the environment.

Performance Standards & Certifications

The EFCO window wall is tested, certified & labeled for the following performance standards:

- AAMA TIR A-11 Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads
- AAMA 501.1 Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
- ASTM E283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen
- ASTM E330 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
- AAMA 1503, NFRC 100 Thermal Transmittance, U-Factors
- AAMA 1503, NFRC 500 Condensation Rating (CRF,CI)
- NFRC 200 Overall Solar Heat Gain Coefficient and Visible Transmittance (SHGC & VT)

Limitations & Comparability

EPDs are not intended for making comparisons with other products due to varying background data in LCA softwares and/or varying Program Operator or Product Category Rules. For example, Product Category Rules may present different modeling decisions or impact category requirements. Different LCA software and background LCI datasets may lead to different results in the life cycle stages declared.

Full conformance with the PCR for products allows EPD comparability only when all stages of a life cycle have been considered, including the product's Use phase in a building. Variations and deviations, as noted above, are likely. If comparisons to other EPDs are done, these variations and deviations must be acknowledged. EPDs are comparable only if they comply with ISO 21930: 2017, use the same sub-category PCR, include all relevant information modules, and are based on equivalent scenarios with respect to the context of construction works.

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