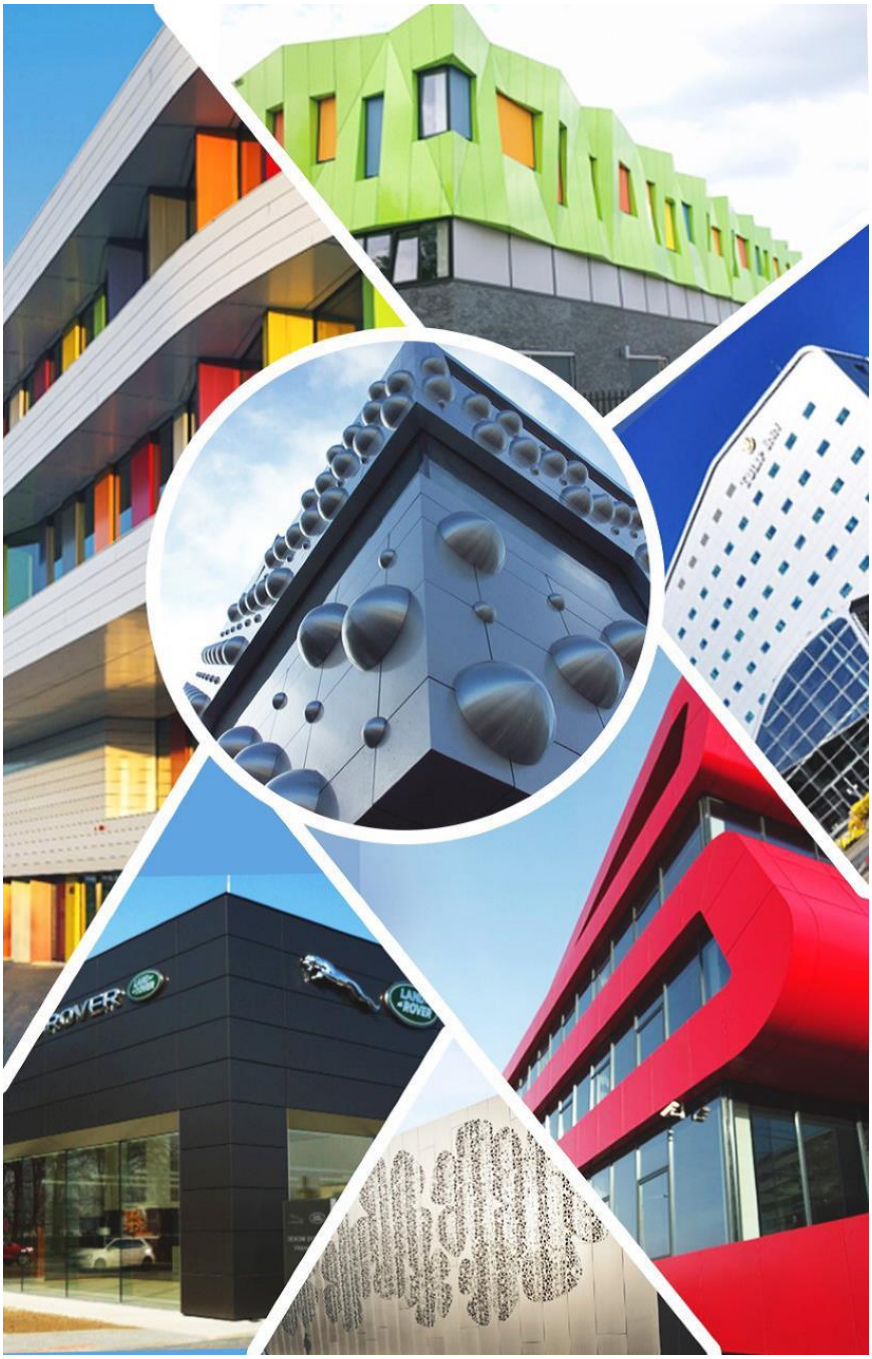
ENVIRONMENTAL PRODUCT DECLARATION

ALUBOND U.S.A. ® FIRE RATED FR B

FIRE RATED ALUMINUM COMPOSITE PANELS

ALUBOND Europe d.o.o.



Worldwide presence of more than 20 years, cooperation on numerous projects all over the globe, with an annual production capacity of more than 25 million m^2 located in 4 countries makes Alubond U.S.A ◦ the World's Largest Metal Composite Brand.

Great potential of shaping, variety of finishes and highest fire resistant products, wide range of colors and possibilities of individualization makes Alubond U.S.A. ◦ an architect's dream material. The willingness to support sustainability and create eco-friendly products leads us toward constant improvements and innovations. Our 100 % recyclable panels meet LEED certification requirements. With our environment-conscious production at all units, we are committed to keep on contributing to efforts to make the World a more beautiful place.

ENVIRONMENTAL PRODUCT DECLARATION

ALUBOND U.S.A. ® FR B
ALUBOND EUROPE d.o.o.

According to ISO 14025 and ISO 21920:2007

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Alubond Europe d.o.o.
DECLARATION NUMBER	4788656130.101.1
DECLARED PRODUCT	Fire Rated Aluminum Metal Composite Panels
REFERENCE PCR	UL Cladding System Products PCR v.1 June 18, 2015
DATE OF ISSUE	July 1, 2019
PERIOD OF VALIDITY	5 Years
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	PCR Peer Review Panel
	Dr. Nicholas Santero, P.E.
	epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	Grant R. Martin
	Grant R. Martin, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas P. Gloria
	Thomas P. Gloria, Industrial Ecology Consultants

This EPD conforms with ISO 21930:2007

Product

This LCA study is conducted for ALUBOND USA FR B Aluminum Composite Panel, which is a specific product produced in Alubond /Serbia manufacturing plant. The variation appears only in paint color and size when product users have specific request depend on project requirements.

Product Description

ALUBOND EUROPE d.o.o., Fire Rated Metal Composite Panel consist of two Aluminum layers, sandwiching a fire rated core in a continuous co-extrusion process. The product has the highest grade of Fire Resistant Aluminum Composite Panels suitable for varied applications and heights.

It consists of a highly fire resistant core constituting a high percentage of minerals like Magnesium Hydroxide, manufactured in a continuous co-extrusion process using inline mechanical and chemical bonding. The fire resistant core is equipped with drop moisture emitters, when heated above 3300 °C.

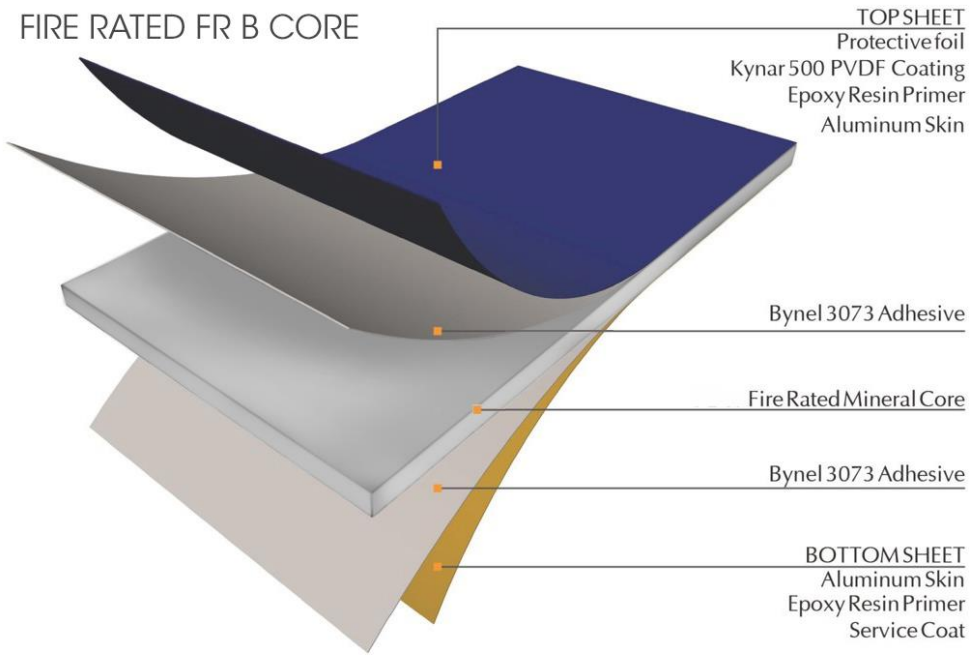


Figure 1. ALUBOND USA FR-B

Application Area

ALUBOND USA FR B is applied to a building exterior to separate a building from the natural environment and provide an outer building skin or layer. It provides fire resistance, control of weather elements to safely direct water and wind, and control run-off and infiltration of other foreign objects into the building structure. It also provides a durable, aesthetically pleasing building appearance.

It can be used on all building exterior surfaces. Its highly malleable property gives flexibility of shapes making it a versatile panel to achieve complex design solutions for exterior and interior use in building industry, as well as in transportation, signage and machine construction.

Technical Information and Product Standards

Technical data relevant to ALUBOND USA FR B Aluminum Composite Panels are shown in below table.

Name	Value	Unit
Standard Length	13	ft
Standard Width	3 / 4	ft
Thickness	0.15	in
Density	0.16	lb/ft^3
Tensile strength	Rm > 140	lbf/in^2 (PSI)
Modulus of Elasticity	> 1015264.16	lbf/in^2 (PSI)
U value of assembly including interruptions to insulation	1.02	$BTU/(h°F\ ft^2)$
R value of typical materials where continuous	5.81	$ft^2\ °F\ hr\ /\ BTU$
Water vapor permanence	N/A	perm (inch-pound)
Liquid water absorption	N/A	% of dry weight
Sound transmission Loss (Rw)	STC: 27	dB
Sound absorption coefficient	0.05	%

Table 1. Technical Data

Life Cycle Assessment Stages and Reported EPD Information

Base Materials

ALUBOND USA FR B Aluminum Composite Panel's primary raw materials are aluminum and fire rated core. The fire-rated core constituents are magnesium hydroxide and LDPE.

The base materials of 100 square ft. composite panel system as mass percentage are shown in the table below.

Name	Value	Unit
Aluminum	36.61	%
Core Material- Magnesium Hydroxide [$Mg(OH)_2$]	45.73	%
Core Material- LDPE	15.24	%
Adhesive Film	1.42	%
Protective Foil	1	%

Table 2. Base Materials as Mass Percentages

Manufacturing

Alubond FR B Aluminum Composite Panel product consists of two peripheral layers of aluminum skin sandwiching a non-combustible mineral with PVDF/ PE coating on the top surface. Panel production follows a continuous co extrusion process using inline mechanical and chemical bonding. Manufacturing flow chart is given in the figure below:

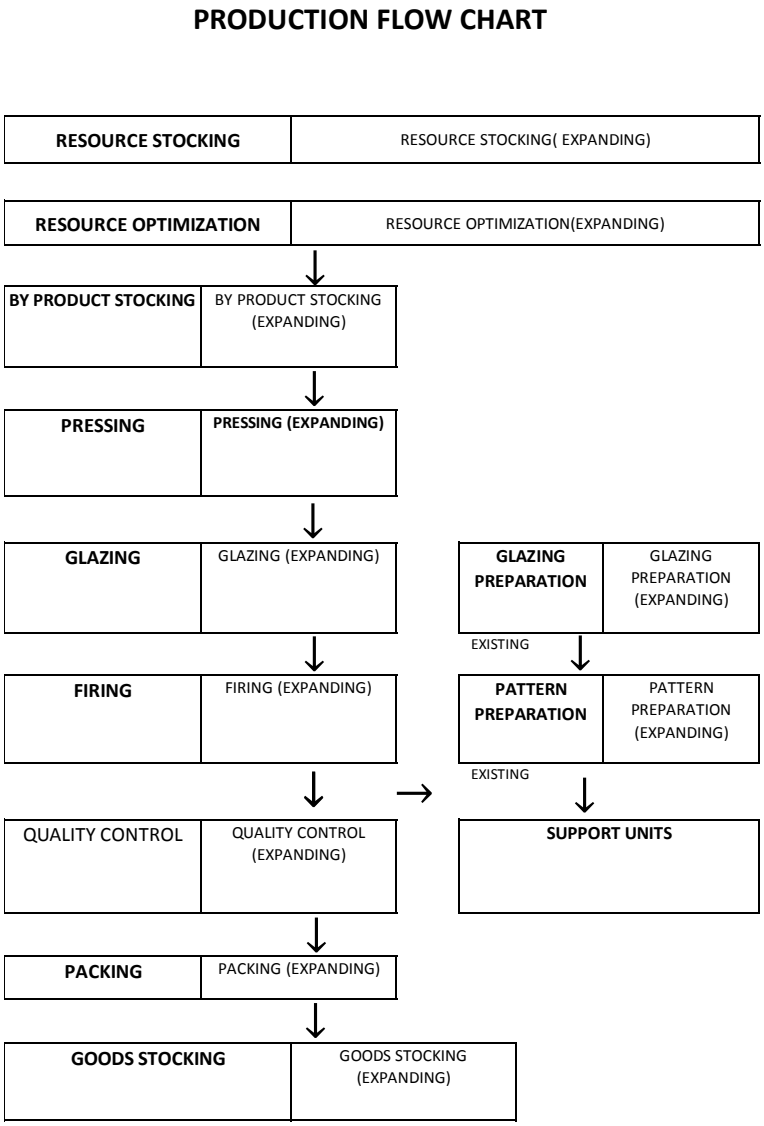


Figure 2. Manufacturing flow chart

Environment and Health Consideration During Manufacturing

No measures over or beyond the statutory requirements are demanded for the manufacture of ALUBOND Aluminum Fire Rated Composite Panels. The manufacturer attests that no threshold of significance has been exceeded for any material and there are no hazardous or toxic releases during production. All emissions are under applicable laws and regulations and residual materials are disposed of in accordance with the respective national guidelines.
For special working areas, e.g. protective clothes, earplugs, protective masks, helmets and safety shoes are used as designated by the authorities. All values established inside and outside the production facility are below the applicable requirements governing noise protection.

Packaging

Wooden pallets, cardboard, steel stripe and strapping nylon are used for packaging of the fire rated composite panels. The packaging materials are easily separable and can be reused if necessary. Most of the packaging materials can be collected sorted by type and directed to regional recycling services. However, disposal of the product packaging (Module A4 & A5) is outside the system boundary of this LCA study, therefore potential environmental loads from recycling of packaging materials are not accounted.

Installation

The ALUBOND U.S.A. Aluminum Composite panels should be installed in accordance with the manufacturer requirements. Manufacturer suggests using the correct tools in good condition to prevent any damage to the product surface during installation. The types of fasteners to install the product are screws and aluminum brace. Although every application for the installation part is not under the control of manufacturer, average data taken for fasteners and other methods of attachments declared by manufacturer is used in A3 product stage. Construction process stage (module A4 and A5) is not taken under consideration for the EPD.

Besides of sheets, it is also being offered delivery of pre routed cassettes to customers which mean that offering delivery of flat cassettes that are made out of sheets at the facility. Accessories or sub construction system are not offered.

Panels are also resistant to industrial atmospheres and are self-cleansing in most environments. As with all claddings, an improvement in durability is achieved by an annual wash down with warm water to avoid the buildup of deposits. Routine cleaning of the surface of product is recommended. It may be washed with water and mild detergent followed by a clean water rinse. The frequency of cleaning and the choice of suitable cleaning agent depend largely on the position of the building being cleaned and degree of contamination. Cleaning of sun-heated surfaces (above 400 C) is not recommended to avoid rapid drying which may lead to stain formation. The cleaning operation must be followed by a through rinse with clean water to ensure the removal of all remnants of the cleaning agent. A final wipe down by means of a sponge, leather or wiper is necessary to avoid water stains. Use stage related to the building usage (Modules B1 through B5) is outside the system boundary of this LCA study.

Alubond FR B Aluminum Composite Panel complies with below standards and regulations below;

 Certificate No. ME5063 Test Procedure and Acceptance in accordance with EN 13501-1: 2009, “Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests”.

 ASTM E119 Level Certification Standard Test Methods for Fire Tests of Building Construction and Materials

 Exova Warringtonfire

Recycling, reuse or repurposes

All Aluminum Composite Panel waste generated during manufacturing and at end-of-life is resulting as recyclable or reusable materials. The packaging materials are easily separable and can be reused when necessary. The residual material of aluminum occurs during sizing activities are collected and directed to regional recycling services. The fire-rated core leaving the manufacturing system as rate of waste can be taken into the manufacturing process of the same product again.

The amount of recycling rate for aluminum by taking into consideration the collection rate and remelting losses is taken 95% depend on the real primary and recycled metal production data of Global Aluminum Recycling Committee. Energy source to manufacture the product is provided from the national grid and no renewable energy is used during manufacturing process.

Disposal

The manufacturer declared that there is no generation of specific waste, which is disposed to landfill or considered as hazardous during the manufacturing of ALUBOND FR-B. The potential waste generated during manufacturing is the fire-rated core material package. The fire-rated core imported with big-bags. After the core material is used, big-bags are sending to closest recycling facility. Aluminum is supplied painted, so considered as no packaging material of paint generated as waste.

Other potential rate of waste (core material and aluminum) occurs during sizing activities. The 4% amount of those combined residual material being sent to recycling facility. There, aluminum scraps are separated from the core material to recycle the aluminum and the left core material sending back to manufacturing plant to reuse again. Aluminum scraps and core material are considered within A3 system boundary.

The amount of aluminum used as raw material is also considered separately in D module to show product recycling potential when life of product finished. Since the recycling of aluminum is a common practice, it was assumed that all end of life product would be over in recycling facility.

Life Cycle Assessment

The LCA study and analysis were conducted according to the Product Category Rule (PCR) created by UL Environment for Cladding System Products version (June 18, 2015) and complies with ISO 14025/14040/14044 standards.

Declared Unit

The declared unit is the 100 sq. ft. of fire-rated aluminum composite panel produced in ALUBOND EUROPE DOO manufacturing plant in Serbia.

System Boundary

The type of this EPD study is cradle to gate – with options. The System Boundary includes A1 through A3 Product Stage and D Module that are accounted for,

- A1 Extraction and processing of raw materials (e.g. mining and refining processes), reuse of products or materials from a previous product system, generation of electricity and other primary energy resources;
- A2 Transportation up to the factory gate and internal transport;
- A3 Manufacturing of packaging materials and waste generation
- D Benefits of loads resulting from reusable products, recyclable materials and/or useful energy carriers leaving a product system

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction & Demolition	Transport	Waste processing	Disposal	Reuse- Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X

Table 3. Description of the System Boundary (X: Included in LCA; MND: Not included)

The system boundary is set to determine the environmental effects of the product from raw material acquisition through to production of product ready for dispatch and the potential recycling benefit of product.

Estimates and Assumptions

ALUBOND USA FR-B Aluminum Composite panel LCA study is conducted in accordance with all methodological considerations, such as performance, system boundaries, data quality, allocation procedures, and decision rules on evaluating inputs and outputs on impact assessment.
However, at some points estimations and assumptions has to be made to fill data gaps that you can see below;

- The recycling rate of aluminum is taken 95% from the real primary and recycled aluminum production data as stated in Global Aluminum Recycling Committee Report.
- All trucks were chosen as Euro 5 type of trucks as stated in national local regulations.
- The amount of mineral core waste from sizing activities that can be reused as raw material input again is not considered in LCA model to calculate the worst conditions.
- The type of cargo ship of fire rated core imported from Dubai is assumed as average ship in GaBi.
- The possible variations in paint color and size is not accounted in this LCA study because there were not enough datasets.
- The weight of big bag data is taken from the Association for Textile Packaging Materials and other Industrial Textiles. The process of big bag recycling has to be selected as landfill data because no data was available in GaBi.

Since the aluminum recycling is a common practice in Serbia, the end of life product is assumed as being sent to aluminum recycling facility

Cut-off Criteria

All inputs and outputs to unit processes for which data are available are included in the calculation. Data gaps are filled by conservative assumptions with average or generic data, as described above.

There is no neglected unit processes more than 1% of total primary energy usage or over 1% of the total mass input of that unit process. The total neglected input and output flows per each group module is not exceed a maximum of 5% of energy usage, mass, and environmental impact category as indicated in the PCR.

The manufacturer attests that no threshold of significance has been exceeded for any material and all emissions are under applicable laws and regulations.

Product Stage (A1-A3) includes the provision of all raw and packaging materials, transportation, energy and waste processing of final residues. No manufacturing process is omitted. However, production of capital goods, infrastructure, production of manufacturing equipment and personnel-related activities are not included in this LCA study.

For conservative assumptions in combination with plausibility considerations an expert judgment can be used to demonstrate compliance in practice. In this assessment, all data from the production stage contain raw material

extraction, production processes, electricity and natural gas used for manufacturing, amount of packaging materials, transportation distances up to the factory gate and generation of waste, as declared by manufacturer.

The following processes are accounted for in this LCA study;

- Extraction and processing of raw materials
- Production and use of fuels and electricity
- Transportation up to the factory gate
- Impacts of fasteners
- Production of ancillary materials or pre-products
- Manufacturing of packaging

And not accounted for;

- HVAC (heating, ventilation, and air conditioning), artificial lighting and transport within the manufacturing site
- Production of capital goods, infrastructure, production of manufacturing equipment and personnel-related activities
- Co-products potential impacts, because no co-product generation in manufacturing system
- Internal transport
- No measured data or reports for accidental pollutions therefore they are not considered
- The personnel related environmental impacts on site
- The possible variations in paint color and size

Allocation

Allocation is made for each flow that reaches the system at the boundary A1 – A3 and D in conformance with ISO 14044 as described in PCR. There is no product coming from the same unit process or product system so no co-product allocation is made.

The amount of materials, energy and transportation inputs are allocated per 100 sq. ft. of product based on total annual production and consumption data.

In order to avoid double counting and omission each module inputs and outputs are balanced without any sub-processes. Thus, the principle of modularity is maintained.

The amount of aluminum being sent to recycling is calculated from the total amount of aluminum used per 100 sq. ft. production and modeled in D module to avoid burden allocation.

Background Data

The LCA model of ALUBOND fire-rated Aluminum Composite Panels was created using GaBi 6.0 product sustainability software by ERKE Sustainable Building Design and Consultancy.

All relevant background data necessary for the product stage (raw materials, energy, transportation) of fire-rated aluminum composite panels were selected from the GaBi database in accordance with the data declared by manufacturer. The data of production processes were selected for production specific or average data from similar production processes in GaBi.

Data Quality and data quality assessment

For consistency and completeness of data, GaBi Product Sustainability Software database version 6.106 is used. The GaBi Software, using worldwide in LCA models, provides the life cycle inventory database for material, energy, transportation and waste flows gathered from manufacturer.

All primary required data for LCA Analysis were taken from the manufacturer in the time period between 01.06.2017 and 01.09.2018 for 12 consecutive months. Datasets used for calculation are attempted to select within the last 10 years. However for a couple of processes, no newer data was available (Table 9) so datasets older than 10 years has to be used. Therefore, these datasets (protective film, packaging tape, cardboard) were identified as low quality data and considered as an opportunity for improvement.

. The specific data quality coverages are:

- Geographical coverage: The study generally applies to the actual situation in Serbia. When there is no specific data for Serbia, European data has been preferred to use as the conditions in Europe are similar with Serbia. European data of raw materials, packaging materials, haulage vehicles, diesel used for transportation and waste has been used substitute for Serbia's specific data. However, using European data which is similar with Serbian data, does not affect the LCA results.
- Time period covered: goal of the study is to determine the actual environmental loads for 12 consecutive months, so data for the period between the dates of 01.06.2014 and 31.05.2015 is used.
- Technology coverage: the objective of the study is to use data that apply to average technology (actual situation). Data available for those processes in GaBi are expected to show limited variability globally.

Life cycle impact assessment

The Life Cycle Inventory Assessment results are documented below for the system boundary stages; A1 through A3 Product Stage and D Module as defined above under System Boundary section in this report. Results are based on characterization factors from the US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts that called TRACI 2.1 Impact Categories. Due to the relative approach of this LCA study, the results include only amount of life cycle impact category parameters based on declared unit.

Impact Assessment Methodology: TRACI 2.0		Unit	A1-A3	D	Total
DECLARED UNIT (100 square ft. composite panel)					
GWP	Global Warming Potential	[kg CO2 Eq.]	2.60E+02	-7.98E+00	2.52E+02
ODP	Depletion potential of the stratospheric ozone layer	[kg CFC 11 Eq.]	7.12E-08	-3.79E-09	6.83E-08
AP	Acidification potential	[kg SO2 Eq.]	1.12E+00	-2.94E-02	1.09+00
EP	Eutrophication potential	[kg N Eq.]	3.48E-02	-9.33E-04	3.39E-02
POCP	Photochemical ozone creation potential	[kg O3 Eq.]	1.26E+01	-3.38E-01	1.22E+01
ADPF (optional)	Abiotic depletion potential for fossil resources	MJ Surplus energy	3.70E+02	-7.73E+00	3.62E+02

Table 4. Life Cycle Impact Assessment Results

Impact Assessment Methodology: TRACI 2.0		Unit	A1-A3	D	Total
DECLARED UNIT (100 square ft. composite panel)					
PERE	Renewable primary energy as energy carrier	[MJ]	1.22E+03	-3.39+01	1.18E+03
PERM	Renewable primary energy resources as material utilization	[MJ]	1.21E-01	-1.28E-11	1.21E-01
PERT	Total use of renewable primary energy resources	[MJ]	1.22E+03	-3.39E+011	1.18E+03
PENRE	Non-renewable primary energy as energy carrier	[MJ]	3.77E+03	-1.09E+02	3.66E+03
PENRM	Non-renewable primary energy as material utilization	[MJ]	2.65E+02	-6.17E+00	2.58E+02
PENRT	Total use of non-renewable primary energy resources	[MJ]	4.04E+03	-1.16E+02	3.92E+03
SM	Use of secondary material	[kg]	-	-	-
RSF	Use of renewable secondary fuels	[MJ]	-	-	-
NRSF	Use of non-renewable secondary fuels	[MJ]	-	-	-
FW	Use of net fresh water	[m3]	3.51E+03	-7.86E+01	3.43E+03

Table 5. Results of LCA – Resource Use

Impact Assessment Methodology: TRACI 2.0		Unit	A1-A3	D	Total
DECLARED UNIT (100 square ft. composite panel)					
HWD	Hazardous waste disposed	[kg]	5.57E-06	5.19E-08	5.62E-06
NHWD	Non-hazardous waste disposed	[kg]	3.23E+02	-1.19E+01	3.11E+02
RWD	Radioactive waste disposed	[kg]	1.98E-01	-9.29E-03	1.89E-01
CRU	Components for re-use	[kg]	-	-	-
MFR	Materials for recycling	[kg]	-	-	-
MER	Materials for energy recovery	[kg]	-	-	-
EEE	Exported electrical energy	[MJ]	-	-	-
EET	Exported thermal energy	[MJ]	-	-	-

Table 6. Results of LCA – Output Flows and Waste Categories

Interpretation

The LCA study shows cradle-to-gate (A1-A3) results and also potential benefits for recycling product of ALUBOND FR-B Aluminum Composite Panels for 100 sq. ft. production under 1-year manufacturing period. The results show that greatest contributor to the environmental impacts for the production of fire-rated aluminum composite panel is extraction of raw materials. The module demonstrated consistently the considerable inputs in environmental impacts as seen on the below chart and presented as a major contributor to all impact categories. The raw material value is primarily dominated by aluminum sheet mix for all impact categories (approx. 85% for GWP) and other remaining part is accounted for by other raw materials such as LDPE.

The LCA study also revealed that transportation plan (A2 module) has relatively lower environmental impacts compared to A1 module which is raw material extraction process. The environmental impacts occur from transportation activities are responsible for less than 12% of all environmental impact categories. This stage mainly contributed by the transportation of fire-rated core which is supplied from Dubai with ships. The A3 product stage accounts maximum 3% (ODP) among all impact categories.

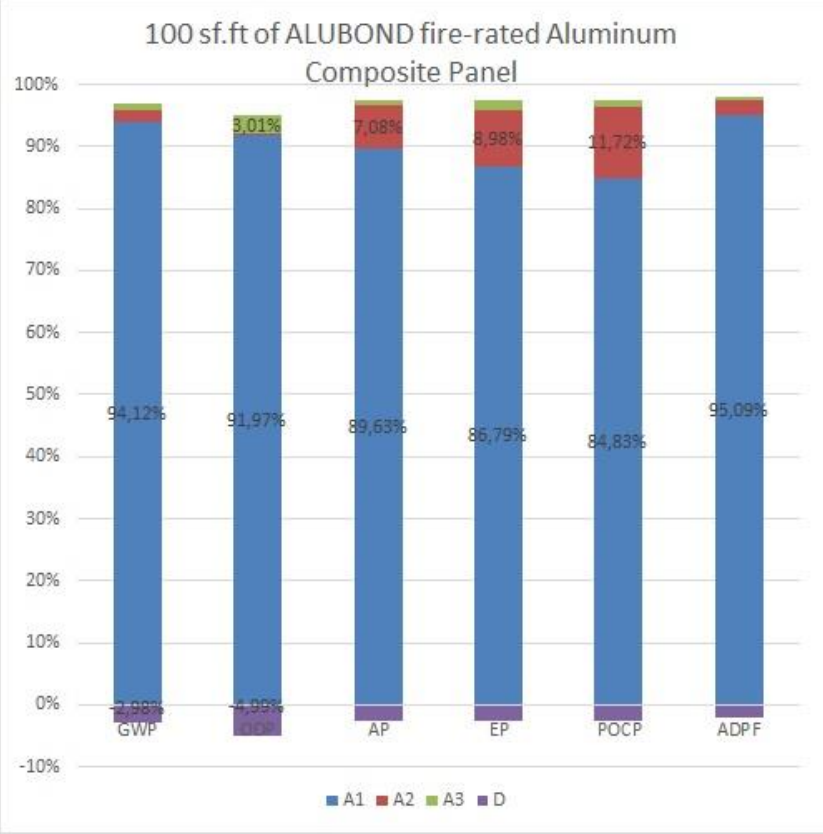


Figure 3. Graph of Life Cycle Stage Impacts

References

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EN 15804	European Committee for Standardization (CEN). "EN15804:2012. Sustainability of construction works – Environmental product declarations— Core rules for the product category of construction products"
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ISO 14044	International Standard Organization. "ISO 14044:200610, Environmental management – Life cycle assessment – Requirements and guidelines (ISO 14044:2006)."
ISO 14025	DIN EN ISO 14025:2011-10: Environmental labels and declarations — Type III environmental declarations — Principles and procedures
TRACI 2.1	Bare, J. "TRACI 2.1: the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts 2.1." US EPA
UL Environment	UL Environment's Program Operator Rules
International Aluminum Institute	Global Aluminum Recycling Rate
UL Environment	Product Category Rule (PCR) for Cladding System Products VERSION (June 18, 2015)

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