Environmental Product Declaration

MITSUBISHI CHEMICAL

MITSUBISHI CHEMICAL INFRATEC CO.,LTD.

ALPOLIC™

ECO PLATFORM EPD VERIFIED

AUSTRALASIA EPD®
ENVIRONMENTAL PRODUCT DECLARATION

Environmental Product Declaration (EPD) in accordance with ISO 14025 and EN 15804:2012+A2:2019, 2020.

Product Name: ALPOLIC™NC / ALPOLIC™ A1 | Non-combustible Aluminium Composite Panel | Product Category Rules (PCR): Construction products; 2019:14; version 1.1.

Programme: The International EPD® System, www.environdec.com

Programme Operator: EPD Australasia Limited | EPD Registration No: S-P-03725 | Publication Date: 2021-08-24 | Version Number 2.0 | Date of Revision: 2022-09-20 | Valid until: 2026-08-24 | Geographical Scope: Final product produced in Japan and sold by Network Architectural in the Australian market.

An EPD should provide current information and may be updated if conditions change. The stated validity is, therefore, subject to the continued registration and publication at www.environdec.com.

Table of Contents

Table of Contents

Table of Contents

Figures

Tables

Important Notice

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

This EPD is verified to be compliant with EN 15804. EPD of construction products may not be comparable if they do not comply with EN15804.

EPDs within the same product category but from different programs or utilising different PCRs may not be comparable.

Declaraton Owner:

Mitsubishi Chemical Infratec Co., Ltd.
Email: info@alpolic.jp
Website: www.alpolic.com
Phone: +81-(0)3-6748-7348

c/o **Network Architectural.**
71-75 Marigold Street, Revesby, NSW, 2212, Australia
Web: www.networkarchitectural.com.au
Phone: (02)8316-5000

EPD produced by:

LCA accountability: Deepali Ghadge, Judith Schinabeck
Good Environmental Choice Australia (GECA)
Email: enquiries@geca.org.au
Website: www.geca.eco
Phone: 02 9699 2850

EPD Program Operator:

EPD Australasia Limited
Post: 315a Hardy Street, Nelson, New Zealand 7010
Email: info@epd-australasia.com
Website: www.epd-australasia.com

Product Category Rules (PCR)

PCR: Construction products; 2019:14; version 1.1, UN CPC code: 314/415/3814 (EPD International, 2020).

PCR review conducted by:
The Technical Committee of the International EPD® System.

Third Party Verification

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:

☐ EPD Verification (Internal)

☑ EPD Verification (External)

Jonas Bengtsson, Edge Environment
L5, 39 East Esplanade, Manly NSW 2095 Australia.

Approved by: EPD Australasia Limited

Procedure Follow-up

Procedure for follow-up of data during EPD validity involves third party verifier:

☑ Yes ☐ No

Executive Summary

Project Goals

ALPOLIC™NC/ALPOLIC™A1 is an Aluminium Composite Material (ACM) suitable for exterior or interior claddings, soffit linings, roof covering in new buildings, and retrofit applications. This report provides details on the background and results of a life cycle assessment study of ALPOLIC™NC/ALPOLIC™A1 conducted for Mitsubishi Chemical Infratec Co., Ltd.

The goal of this project is to quantify the environmental performance of ALPOLIC™NC/ALPOLIC™A1 throughout the life cycle including material extraction, production and end of life to construct an environmental product declaration (EPD) according to Construction Products PCR. The declared unit of this study is 1m2 of an ALPOLIC™NC/ALPOLIC™A1 Aluminium Composite Panel.

Life Cycle Assessment Results

The impact results of the ALPOLIC™NC/ALPOLIC™A1 are presented per declared unit in respect of different impact indicators. Endpoint impact indicators are not included in this study.

The upstream module which includes raw materials extraction is the highest contributor of impacts for all impact indicators including global warming potential. The casting process of aluminium coils, the use of aluminium hydroxide and polyurethane foam used in the packaging material is the main noticeable impact contributor to the upstream process.

The second-largest impact contributor is the downstream process, module A4 which is the transportation of the final product on-site by the distributor. Module D includes two recycling scenarios of aluminium from ACM (aluminium composite material) including packaging material (steel drum) recycling. Both scenarios represent negative impact values which indicate environmental benefits due to the reduction of disposal impact burden and reduction of a raw material demand for the future life cycle. Recycling of aluminium lowers the environmental impact for all impact indicators except the hazardous waste flow indicator.

Some of the recommendations for impact reduction have been addressed in this report; for example, downstream process (Module A4) impact can be reduced through direct transportation of the aluminium product to the construction site. Use of alternate material and reusing of the packaging materials are the option of impact reduction from upstream process (Module A1).

MITSUBISHI CHEMICAL
MITSUBISHI CHEMICAL INFRATEC CO.,LTD.
ALPOLIC™

Summary of Changes from Previous Version 1.0

Changes in Background LCA Report Content

- Provided reference for Data Quality Assessment in Table 2.
- Clarified requirement for Temporal scope in Section 2.2 and Table 2.
- Correction of mass-balance in Table 4 by subtracting recycled amount.
- Clarification on assumption for transport calculation in Section 8.2.
- Clarification on assumptions for different modules and their impact on LCA results. Section 8.1.
- Addition of transportation table along with capacity factor in Appendix Section 8.2.
- Added statement about cut-off of 1% primary energy and 1% total mass input in section 3.2 Foreground data.
- Included the statement that "scenarios included are currently in use and are representative for one of the most probable alternatives" in Section 2.5 Allocation and LCA modelling scenario.
- Added disclaimers related to Impact Indicators to Table 5.
- Addition of Executive Summary.

Editorial Changes

- Corrected editorial error in Table 2, Table 3, Table 5 and Table 12.
- Corrected editorial error in Section 2.1, Section 2.6.3, Section 5.2.
- Corrected general editorial errors related to 'Declared Unit' and EN15804 standard version number.

1. Introduction

1.1 Project Background

ALPOLIC™NC/ALPOLIC™A1 is an Aluminium Composite Material (ACM) with a non-combustible core, suitable for exterior or interior claddings, soffit linings and roof covering in new buildings and retrofit applications wherever a non-combustible material is required. The ALPOLIC™NC/ALPOLIC™A1 product is manufactured by Mitsubishi Chemical Infratec Co., Ltd. and is furnished by approved distributors and authorised dealers. ALPOLIC™A1 is another name of the brand. Network Architectural is the distributor for ALPOLIC™NC/ALPOLIC™A1 in Australia.

Good Environmental Choice Australia (GECA) has performed a life cycle assessment (LCA) for ALPOLIC™NC/ALPOLIC™A1 as detailed in this report. It serves as the background report for an Environmental Product Declaration (EPD), which transparently shows the environmental impacts of the product and will be published separately. The corresponding EPD is constructed according to the Product Category Rules (PCR) 'Construction Products' (EPD International, 2021) and will be registered under the EPD Australasia programme.

1.2 A Brief Introduction to Life Cycle Assessment

Life cycle assessment is a methodology for assessing the full cradle to grave environmental benefits of products and processes by measuring the environmental flows at each stage of the life cycle. An LCA aims to include all important environmental impacts for the product system being studied. The framework and specific requirements of LCAs are described in the international standards ISO 14040 and ISO 14044.

The first stage is the 'Goal and Scope', which describes the reasons for the LCA: the scenarios, boundaries, indicators, and other methodological approaches used (ISO 14040, 2006). The second stage is the 'Inventory Analysis', which builds a model of the production systems involved in each of the scenarios and describes how each stage in the production process interacts with the environment. This is typically based on existing environmental databases. The third stage is 'Impact Assessment'. In this stage, the inventory data is related to the impacts of concern to produce an environmental profile for each of the scenarios. The final stage is the 'Interpretation', where the results are analysed, and systematic checks of the data and assumptions are undertaken to determine the robustness of the results (ISO 14044, 2016).

1.3 A Brief Introduction to Environmental Product Declarations

An Environmental Product Declaration (EPD) is an independently verified and registered document that reports the actual data associated with the environmental impacts of a product across its entire life cycle. It is based on a lifecycle assessment and other relevant product or service information, such as physical properties and background information on production methods. EPDs are developed and verified per the international standard ISO 14025 and are known as Type III environmental declaration (ISO 14025, 2006).

These declarations are generally intended for business-to-business communication but can be used by consumers provided they are third-party verified and registered with an EPD programme, such as EPD Australasia. EPDs registered with EPD Australasia must follow the International Environmental Product Declaration System.

According to ISO 14025, Product Category Rules (PCR) are a set of specific rules, requirements, and guidelines for developing Type III Environmental Declarations for one or more product/service categories (ISO 14025, 2006). These documents state the rules for the underlying life cycle assessment and set minimum requirements on EPDs for a specific product group that is more detailed than the standards and the General Programme Instructions (EPD International , 2021).

ALPOLIC™NC/ALPOLIC™A1 fits the PCR 'Construction Products'. This document is the main implementation of the European standard EN 15804:2012+A2:2019, 2020, Sustainability of construction works — Environmental product declarations, in the International EPD® System. They define the construction product by following European construction product regulation as follows: "Construction product means any product or kit which is produced and placed on the market for incorporation in a permanent manner in construction works or parts thereof, and the performance of which affects the performance of the construction works to the basic requirements for construction works" (The International EPD System, 2021).

2. Goal and Scope

2.1 Goal of the Assessment

The goal of this life cycle assessment project is to quantify the full extent of the environmental impacts of ALPOLIC™NC/ALPOLIC™A1, including material extraction, production, and end of life product stages, and to construct an EPD in accordance with Construction Products PCR. The detailed results listed in this report are intended for internal use within Mitsubishi Chemical Infratec Co., Ltd. only. This report has been peer-reviewed by Laura Loucks and Bryan Sheehan of Edge Environment in two rounds in August 2021.

2.2 Geographical and Temporal Scope

ALPOLIC™NC/ALPOLIC™A1 is manufactured in Japan and the suppliers of materials used in this product are also from Japan. The product is distributed globally. Since Network Architectural is the Australian supplier, the inventory includes Australian-specific data along with global data.

The geographical scope is Japan and Australia. The temporal scope of the study is the period for which the data was collected. The data of a 1-year average (2020-2021) was collected by the LCA author from January 2021-April 2021.

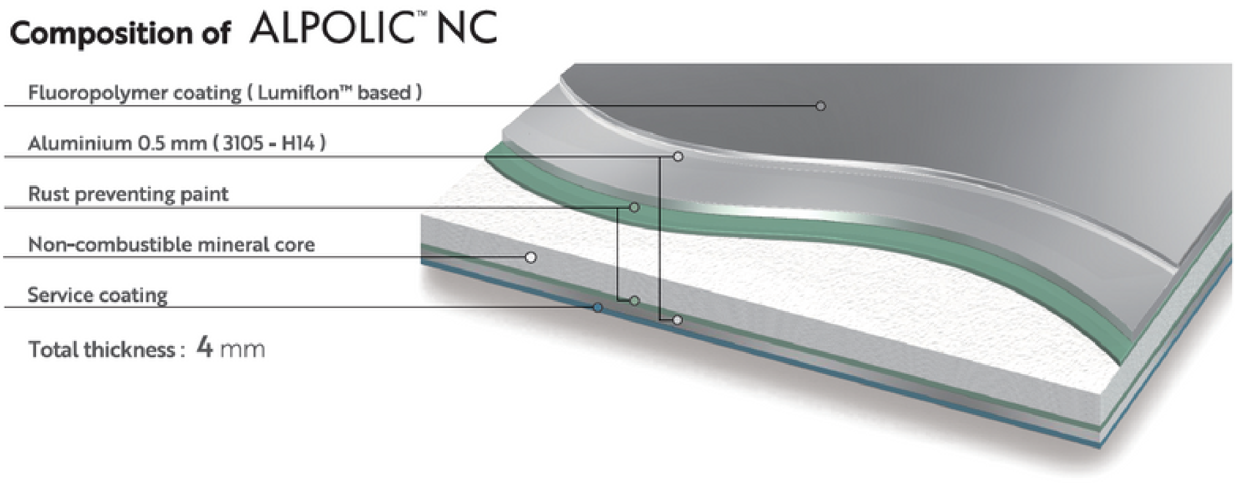

Figure 1 ALPOLIC™NC/ALPOLIC™A1

According to the information provided by Mitsubishi Chemical Infratec Co., Ltd. and Network Architectural, ALPOLIC™NC/ALPOLIC™A1 is composed of a non-combustible core sandwiched between two skins of 0.5mm thick aluminium alloy (3105-H14). The front surface of this product is finished with Lumiflon based fluoropolymer coating. These finishes are available in solid colours, metallic colours, sparkling colours, and prismatic colours and patterns. For the LCA study, a metallic-based colour by Bonflon is selected. The backside which faces the structural wall or steel after the installation, as a cladding panel, has a polyester-based coating or a service coating as corrosion protection. The surface is also protected with a co-extruded white and black coloured removable and self-adhesive film.

The product is made of 50% recycled Aluminium and all Aluminium can be recycled at the end of the product's life.

2.3 Declared Unit and Reference Flow

According to EN 15804, 'A functional unit or declared unit provides a reference by means of which the material flows (input and output data) for each information module of a construction product are normalised (in a mathematical sense) to produce data, expressed on a common basis. The functional or declared unit should be clearly defined and measurable as it provides a reference for combining material flows attributed to the construction product and for the addition of environmental impacts for the selected stages of the construction product's life cycle at the building level (EN 15804:2012+A2:2019, 2020).

For ALPOLIC™NC/ALPOLIC™A1, a declared unit will be taken into consideration instead of a functional unit as mentioned in EN15804 and Construction Products PCR Section 4.1. As per EN15804, the product can be used in multiple ways in construction works (EN 15804:2012+A2:2019, 2020; The International EPD System, 2021).

The declared unit of this study is 1m2 of an ALPOLIC™NC/ALPOLIC™A1 Aluminium Composite Panel over a 20-year life cycle from cradle to gate with options, based on the relevant Product Category Rules (The International EPD System, 2021)

1m2 is chosen as the sheets are transported to the suppliers in this size. 'm2' is an SI unit and it is commonly used in design, planning, and sale.

The declared unit is chosen to be a surface area of 1m2 as the product comes with a constant 4mm thickness.

The reference service life is taken as 20 years as per information provided by Mitsubishi Chemical Infratec Co., Ltd. They performed an AAMA 2605 test which determines the humidity resistance of the Aluminium Composite Panel. To test the durability of the coating, a salt spray resistance test was performed. A weathering resistance test was also performed in accordance with AAMA 2605 and ASTM C 48 (Cycle A). The 20-year reference service life was determined based on the results obtained for resistance against humidity, salinity, and weathering.

2.4 System Boundary

The system boundary describes the life cycle stages and the processes included in the LCA. The stages include raw material supply (A1), transportation (A2), manufacturing (A3), optional transport to the final site (A4), deconstruction (C1), transport at end-of-life (C2), waste processing (C3), waste disposal (C4) as well as reuse, recycling, and recovery. The module selected for this study is 'Cradle to Gate with options – 'modules C1–C4' and 'module D''. An additional module - 'module A4' includes transportation of the final product from the manufacturer to the distributer's location. It doesn't include the transportation from the distributor's location to the construction site. However, the manufacturing of production equipment, buildings, vehicle production, maintenance and other capital goods, business travels of personnel, and labour work are not counted in this study. The excluded processes are assumed to have a negligible contribution to the overall LCA results. While the principal criterion is to include all flows that contribute to more than 1% of the environmental impacts, when in doubt, smaller flows were included rather than excluded, because the exact contribution would be difficult to determine from the start.

Table 1 Life Cycle Stages of ALPOLIC™NC/ALPOLIC™A1

	Life Cycle Stage		Life Cycle Module	Declared Module
Upstream processes	A1	Raw material supply	Product stage	X
Core Processes	A2	Transportation		X
	A3	Manufacturing		X
Downstream Processes	A4	Transport to distributor	Construction stage	X
	A5	Installation at the construction site		ND
	B1	Use	Use stage	ND
	B2	Maintenance		ND
	B3	Repair		ND
	B4	Replacement		ND
	B5	Refurbishment		ND

	B6	Energy use to operate building-integrated technical systems		ND
	B7	Operational water uses by building integrated technical systems		ND
	C1	Deconstruction	End-of-life stage	X
	C2	Transport		X
	C3	Waste processing		X
	C4	Waste disposal		X
Other Environmental Stage	D	Reuse recovery recycling potential	Reuse, recovery, recycling stage	X

2.5 Allocation and LCA Modelling Scenario

In the manufacturing of ALPOLIC™NC/ALPOLIC™A1, no co-product or by-product is obtained. Allocation of any production process to more than one product is therefore not needed.

In the framework of the International EPD System, the methodological choices for allocating reuse, recycling, and recovery have been set according to the polluter pays principle (PPP). This means that the generator of the waste shall carry the full environmental impact until the point in the product's life cycle at which the waste is transported to a scrapyard or the gate of a waste processing plant (collection site). The subsequent user of the waste shall then carry the environmental impact from the processing and refinement of the waste, but not the environmental impact caused in any previous life cycles (EPD International , 2021).

Allocations that were directly embedded in the LCA database processes were adopted. The energy and water calculations are allocated based on the consumption of electricity and production of ALPOLIC™NC/ALPOLIC™A1 in the Mitsubishi Chemical Infratec Co., Ltd. manufacturing unit. Electricity, gas, and water consumption are calculated based on the production volume of the year 2020. The total energy/water consumed by the manufacturing unit in Japan was divided by the volume of ALPOLIC™NC/ALPOLIC™A1 produced for that year to find the individual consumption value of each product.

A sensitivity analysis was conducted for different end-of-life treatment scenarios. Scenarios included are currently in use and are representative for one of the most probable alternatives. In scenario 1, the LCA is modelled with an assumption that 100% Aluminium is recovered from the Aluminium Composite Panel at the end of its reference life of 20 years. In scenario 2, the LCA is modelled with an assumption that only 50% of the Aluminium is recycled. It is assumed that heat treatment is used to separate Aluminium from other composite materials. The assumption is that recycling occurs in the Australian market. The rest of the product ends up in the sanitary landfill.

The end-of-life of packaging by the suppliers is also taken into consideration. However, only packaging material like steel is recycled. The rest were considered to end up in the sanitary landfill.

2.6 Process Diagram

The life cycle of ALPOLIC™NC/ALPOLIC™A1 is divided into three different processes – upstream, core, and downstream processes. The upstream processes include the flows of raw materials. The core processes include all activities which the manufacturing organisation is in control of, e.g., transportation of the materials to the manufacturing factory and the actual process of manufacturing the final product. The downstream processes include the steps that are controlled by a consumer and the disposal or recycling options of the products. The figure below shows the process diagram of ALPOLIC™NC/ALPOLIC™A1. The boxes in green are the flows included in this study's system boundary. The installation and use phases of the product are not included in this project, in line with the 'cradle to gate with options' modelling according to the relevant product category rules (The International EPD System, 2021).

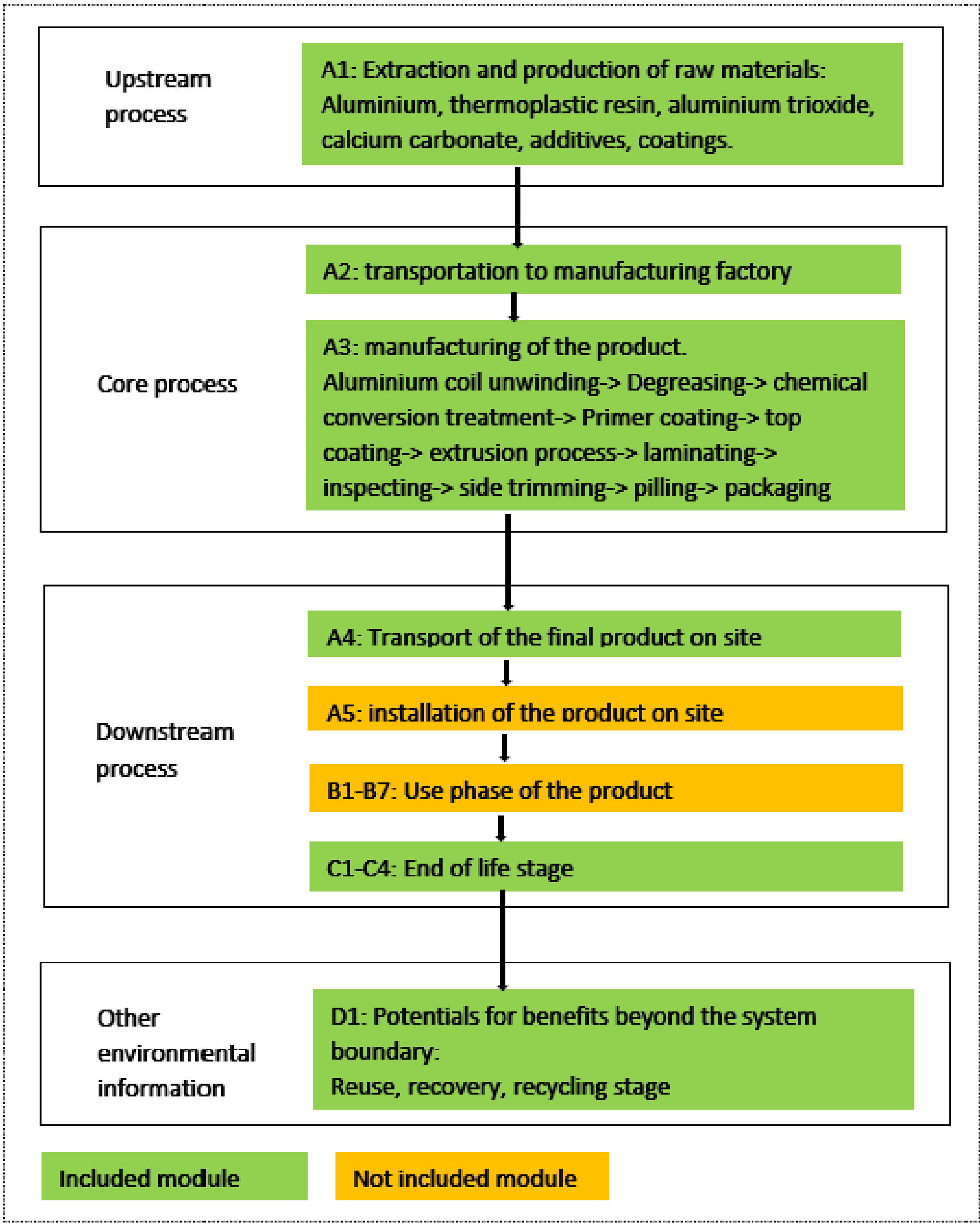

Figure 2 Process Diagram

2.6.1 Upstream Processes

The upstream process consists of the extraction and manufacturing of raw materials. It is assumed that aluminium coil is manufactured by the supplier by using a casting process, where a steel mould is used to shape molten aluminium under pressure. 50% of the total aluminium content is raw aluminium and 50% is recycled aluminium. The raw materials - calcium carbonate and aluminium tri-hydroxide are part of the upstream process.

The thermoplastic resin used is polyvinyl butyral (PVB), a transparent, tough, and flexible thermoplastic with high optical clarity and good adhesion to many substrates.

The coatings include LUMIFLON based paint and primer (Epoxy, Polyester). The paint has ingredients like cyclohexane, xylene, and ethylbenzene. The additive used is methyl methacrylate (MMA).

This section also includes packaging materials. The general packaging materials are steel drums for paints, paper, and plastic films. The final product is packed in wooden boxes which are insulated internally with Polyurethane foam. The details of packaging materials are provided by Mitsubishi Chemical Infratec Co., Ltd. but the quantity is assumed as 9% of the total weight by researching industrial average packaging per product (Pongrácz, 2007).

2.6.2 Core Processes

This process includes the transportation of materials from the suppliers to the manufacturing unit in Japan. It also includes the entire manufacturing process involved for the Aluminium Composite Panel. The manufacturing process starts with the unwinding of the aluminium coil, followed by cleaning and degreasing the surfaces. The surface goes through chemical conversion treatment and then a primer coat is applied to it. A top layer of paint is applied to the surface and its appearance is visually inspected. After inspection, the coil is unwound and then laminated with the core material and a protective film coat. The sides are then trimmed to achieve the required width, and the panel is cut to achieve the required length. The product is then packed after a final visual inspection.

2.6.3 Downstream Processes

The final product is transported from Mitsubishi Chemical Infratec Co., Ltd., Japan to Network Architectural (Distributors) in New South Wales, Australia via road and sea transport. This is later transported to the construction site by the distributors. The deconstruction phase, which is carried out manually, is also considered in this study. Once the product is deconstructed it is transported to resource recovery facilities. The end-of-life transport from the consumer point to a resource recovery centre is considered as 100 km.

The aluminium skin can be physically separated from the core materials. This process is manual and requires ripping the aluminium and core materials apart from each other. This aluminium is recyclable.

For scenario 1, an assumption is made that 100% aluminium from the ACM is recycled after being separated from the other composite materials.For scenario 2 it is assumed that only 50% of the product could be recovered and hence only that much could be recycled. The steel drum packaging from the suppliers is also recycled, while the rest of the materials end up in sanitary landfill.

3. Life Cycle Inventory

3.1 Software and Database

The life cycle assessment is calculated in the software SimaPro 9.1.1. SimaPro includes access to and many of the leading databases in the LCA industry. Data are taken from Ecoinvent 3.6 cut-off criteria, AUSLCI V1.36, USLCI 2015 and Industry Data 2.0. Although Simapro 9.1.1 includes many databases with datasets for thousands of processes, some specific processes might not find an exact match in the available databases. In that case, the closest process in SimaPro 9.1.1 is chosen as an equivalent.

Ecoinvent 3.6- September 2019 has more than 15,000 LCI datasets from sectors like agriculture, energy supply, transport, packaging materials, dairy, wood, biofuels and biomaterials, metals, electronics, and waste treatment (SimaPro , 2019).

Industry Data 2.0 - December 2019 version has processes from Plastic Europe, which is suggested by the PCR, for including plastic polymers as raw materials.

The AUSLCI V1.3 - 6 March 2021 database is an Australian-specific life cycle inventory. It contains a shadow database of modified Ecoinvent 2.2 processes.

The U.S. Life Cycle Inventory Database - 2015 version from National Renewable Energy Laboratory, is a publicly available database that allows users to objectively review and compare analysis results that are based on similar data collection and analysis methods.

3.2 Foreground Data

According to the Construction Products PCR, the life cycle inventory data shall, according to EN 15804, include a minimum of 95% of total inflows (mass and energy) per module. In case of insufficient input data for a unit process, the cut-off criteria shall be 1% of primary energy usage and 1 % of the total mass input of that unit process. Proxy data or extrapolation should be used to achieve 100% completeness if only 95% of total inflow data is available. Inflows not included in the LCA shall be documented in the EPD (The International EPD System, 2021).

For this study, 100% inflows required in the manufacturing of ALPOLIC™NC/ALPOLIC™A1 are taken into consideration.

The raw material and the supplier information is provided by Mitsubishi Chemical Infratec Co., Ltd. which is specific to the product. The information is provided per declared unit. The transport distance between the supplier and Mitsubishi Chemical Infratec's factory was provided in kilometres.

Mitsubishi Chemical Infratec Co., Ltd. provided the specific details for the entire manufacturing process of this Aluminium Composite Panel in the form of a flow chart.

The energy and water usage per functional unit is calculated by dividing the energy usage reported on utility bills by the quantity of production of ALPOLIC™NC/ALPOLIC™A1 panels at Mitsubishi Chemical Infratec's factory in Japan. The energy and water usage per declared unit is calculated by dividing these utility bills by the production quantity of ALPOLIC™NC/ALPOLIC™A1 panels at Mitsubishi Chemical Infratec's factory in Japan.

Mitsubishi Chemical Infratec Co., Ltd. also provided information about the packaging materials. The packaging materials from the suppliers are assumed as 9% of the total weight of the materials from suppliers (Pongrácz, 2007).

The final product is packed in a wooden box that is stuffed with Polystyrene foam to avoid damages. The Polystyrene foam used for packaging in the final product is considered as 9% of the total weight of the product.

The wooden box in which the final products are placed weighs 72.8kgs. This wooden box can fit 90 panels of 1m2 area each. Hence, the weight of wooden box packaging assumed for one 1m2 of ALPOLIC™NC/ALPOLIC™A1 panels is calculated as 72.8kg per 90 panels which is equal to 0.8 kg per panel.

3.3 Background Data

The overall temporal scope for background data is less than 10 years. The temporal scope for AUSLCI V1.36, a shadow database of modified Eecoinvent 2.2 processes is March 2021. For Eecoinvent 3.6 the temporal scope is September 2019. The USLCI 2015 dataset has the temporal scope of 2015 (SimaPro , 2019).

For geographical scope, background datasets and activities which are within Australia are taken from AUSLCI and are Australian-specific unit processes. For datasets and activities in Japan, the library used is Ecoinvent and the global scope is taken into consideration except for electricity use where Japan-specific data was available in the AusLCI library.

3.4 Assessment of Quality, Precision, Completeness, and Representativeness of Data

Data was collected from Mitsubishi Chemical Infratec Co., Ltd., via online forms, online meetings, and emails. Mitsubishi Chemical Infratec Co., Ltd. disclosed the ingredient list of its final product and the paint coating used on the final product by providing the Material Datasheets (MSDS). They also shared information about the materials, their quantities, and the suppliers in detail, including information about packaging materials, mode of transport used for raw materials to reach the manufacturing point, and the distance between them. Mitsubishi shared a flow chart of the manufacturing process in the manufacturing unit.

The data quality assessment is based on EN 15804. (EN 15804:2012+A2:2019, 2020).

Table 2 Data Quality

Module	Input/Output	Data resource	Temporal Scope	Data Quality*
A1, A2	Raw materials used for product manufacture	Mitsubishi Chemical Infratec Co., Ltd. provided a Material Datasheet (MSDS) of the product and the paint coating used on the product. They also provided information on different packaging materials used by the suppliers. The photos of the final packaging materials were provided by them. They shared the manufacturing process of the product by explaining it through flowcharts. The Energy use (Electricity and Gas) and Water use per declared unit are calculated by dividing the energy usage reported on utility bills by the quantity of production of ALPOLIC™NC/ALPOLIC™A1 panels at Mitsubishi Chemical Infratec's factory in Japan.	2020-2021	Very good
	Aluminium transport			
	Aluminium hydroxide			
	Aluminium trioxide transport			
	Calcium carbonate			
	Calcium carbonate transport			
	Plastic Film (Calcium carbonate packaging)			
	Thermoplastic Resin			
	Thermoplastic Resin transport			
	Paper (Thermoplastic resin packaging)			
	Additive MMA			
	Additive MMA transport			
	Paper (Additives MMA packaging)			
	Primer-Epoxy			
	Primer epoxy transport			
	Steel drum (Packaging for primer)			
	Paint-ingredients			
	Paint coating transport			
	Steel drum (Packaging for paints)			
	Final product packaging (Foam and Wooden Box)			
A3	Manufacturing process for Aluminium Composite Panels		2020-2021	Very good
	Water usage in manufacturing factory		2020-2021	
	Energy Usage in manufacturing factory			
A4	Port transport to Network Architectural	Distance between Mitsubishi, Japan, and their Australian suppliers Network Architectural	2020-2021	Very good
	Japan to Australia-Sea transport			
	Manufacturing factory to Port Transport			
C1	Manual Deconstruction	Network Architectural provided information that the product needs to be manually deconstructed.	2020-2021	Very good
C2	End of the life Transport-100km distance is assumed for	Assumption- Average distance of 100km is taken into	2020-2021	Good

	transport to resource recovery and waste treatment facility	consideration as per resource recovery facilities in Australia.		
C3	End of the life treatment- Treatment to separate Aluminium from other materials in the panel- Manual separation of Aluminium from other core materials.	Information provided by Mitsubishi Chemical Infratec on how product can be manually separated at end of life.		Fair
C4	End of the life- and disposal of other materials through sanitary landfill	Assumption that materials end up in sanitary landfills.		Fair
D	Recycling of Aluminium, and steel drum packaging used as Paints and Primer containers.	Assumption that Aluminium is recycled in Australia. Mitsubishi Chemical Infratec provided information that steel drums from Primers and Paints are recycled.	----	Fair
Note* Very good (Data from area and processes under study, within 3-year timeframe) Fair (Data from area with similar conditions, similar technology, within 3-year timeframe, based on assumptions) Good (Data from area and processes under study with similar technologies, within 3-year timeframe)				

Table 3 includes the inflows and outflows of the processes related to the life cycle of ALPOLIC™NC/ALPOLIC™A1 per declared unit. Since the core processes of degreasing and coil coating already include energy and water inputs, they were eliminated as separate inputs in order to avoid double-counting. The coil coating input is taken from USLCI and converted to a global scale. For the manufacturing of liquid and scrap aluminium into an aluminium coil in the upstream process from the supplier, a general manufacturing process was used. Since the suppliers are from Japan, the electricity mix of Japan was used instead of a global electricity mix.

Table 3 Lifecycle input and libraries

Process	Materials/fuels	Amount	Unit	Library
Module A1-A4				
Raw material Aluminium + 50% recycled Aluminium	Aluminium, primary, ingot {RoW}| market for | Cut-off, U	1.36	kg	Ecoinvent 3.6
	Aluminium scrap, post-consumer {GLO}| Aluminium scrap, post-consumer, Recycled Content cut-off | Cut-off, U	1.36	kg	
	Metal working, average for Aluminium product manufacturing {GLO}| market for | Cut-off, U (JP electricity mix)	2.72	kg	Ecoinvent 3.6

Table 2 Data Quality

Aluminium transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.816	tkm	
Aluminium hydroxide	Aluminium hydroxide {GLO}| market for | Cut-off, U	4.41	kg	
Aluminium trioxide transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.6658	tkm	
Calcium carbonate	Calcium carbonate, precipitated {RoW}| market for calcium carbonate, precipitated | Cut-off, U	1.17	kg	
Calcium carbonate transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.2821	tkm	
Calcium carbonate Packaging	Polypropylene, granulate {GLO}| market for | Cut-off, U/Extrusion, plastic film {GLO}| market for | Cut-off, U/Weaving, synthetic fibre {GLO}| market for weaving, synthetic fibre | Cut-off, U	0.1053	kg	
Thermoplastic Resin	Unsaturated polyester, resin, at plant/kg/RNA	0.25	kg	USLCI 2015
Thermoplastic Resin transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.081577	tkm	Ecoinvent 3.6
Thermoplastic resin packaging	Kraft paper, unbleached {GLO}| market for | Cut-off, U	0.022905	kg	
Additive MMA	Methyl methacrylate {RoW}| production | Cut-off, U	0.02	kg	
Additive MMA transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.002905	tkm	
Additives mma packaging	Kraft paper, unbleached {GLO}| market for | Cut-off, U	0.00162	kg	
Primer-Epoxy	Epoxy resin, liquid {RoW}| market for epoxy resin, liquid | Cut-off, U	0.03	kg	
Primer epoxy transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.0027	tkm	
Primer epoxy Packaging-Steel drum	Steel, low-alloyed {GLO}| market for | Cut-off, U	0.000774	kg	
	Metal working, average for steel product manufacturing {GLO}| market for | Cut-off, U	0.000774	kg	
Paint-ingredients	Xylene {RER}| market for xylene | Cut-off, U	0.016	kg	
	Ethyl benzene {RoW}| production | Cut-off, U	0.0144	kg	
	Cyclohexanone {RoW}| market for cyclohexanone | Cut-off, U	0.004	kg	

Paint coating transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.016014	tkm	
Paint Packaging-Steel drum	Steel, low-alloyed {GLO}| market for | Cut-off, U	0.00918	kg	
	Metal working, average for steel product manufacturing {GLO}| market for | Cut-off, U	0.00918	kg	
Final product packaging	Sawnwood, board, softwood, raw, dried (u=20%) {GLO}| market for | Cut-off, U	0.8	kg	
	Polyurethane, flexible foam {RoW}| market for polyurethane, flexible foam | Cut-off, U	0.774	kg	
Degreasing	Degreasing, metal part in alkaline bath {GLO}| market for | Cut-off, U	1	m^2	
Primer coating	Coil, coating, m^2, at plant/m2/RNA with Japan energy mix	1	m^2	USLCI 2015
Colour coating	Coil, coating, m^2, at plant/m2/RNA with Japan energy mix	1	m^2	
Water usage	Water, completely softened {RoW}| market for water, completely softened | Cut-off, U	1.5	kg	Ecoinvent 3.6
Energy Usage	Electricity, medium voltage, at grid/JP U/AusSD U	0.037	kWh	AUSLCI 1.36*
	Heat, district or industrial, natural gas {GLO}| market group for | Cut-off, U	37	MJ	Ecoinvent 3.6
Port to network architectural	Transport, lorry 7.5-16t, EURO3/RER U/AusSD U	0.205	tkm	AUSLCI 1.36
Japan to Australia-Sea transport	Transport, barge/RER U/AusSD U	82.5	tkm	
Manufacturing factory to Port Transport	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	2.67	tkm	Ecoinvent 3.6
Module C1- C4				
End of life Transport of supplier packaging waste	Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U	0.536	tkm	Ecoinvent 3.6
End of life Transport	Transport, lorry 16-32t, EURO5/RER U/AusSD U	10.2	tkm	AUSLCI 1.36
Energy consumed in the end-of-life treatment	Heat, district or industrial, natural gas {GLO}| market group for | Cut-off, U	2	MJ	Ecoinvent 3.6

End of life (Packaging materials and Aluminium disposal if not recycled)	Disposal, polyurethane, 0.2% water, to sanitary landfill/CH U/AusSD U	0.774	kg	AUSLCI 1.36
	Municipal solid waste {RoW}| treatment of, sanitary landfill | Cut-off, U	0.1195	kg	Ecoinvent 3.6
	waste treatment, wood and wood-waste, low degradation assumption, at landfill/AU U	0.8	Kg	AUSLCI 1.36
	Disposal, inert waste, 5% water, to inert material landfill/CH U/AusSD U	8.68	kg	AUSLCI 1.36
Module D				
(Recycling of Aluminium and steel)	recycling Aluminium/AU U	2.72	kg	AUSLCI 1.36
	Steel and iron (waste treatment) {GLO}| recycling of steel and iron | Cut-off, U	0.009954	kg	Ecoinvent 3.6
*AusLCI data 'Electricity, medium voltage, at grid/JP U/AusSD' is based on electricity data from 2013.				

For mass balance, the inflows in the upstream processes are 10.715 kg, which includes 8.6 kg of 1m2 ALPOLIC™NC/ALPOLIC™A1 and the weight of packaging from the suppliers and the final packaging. For the end of the life, it is considered that the product ends up in a sanitary landfill. In case of packaging, only the steel drum is recycled whereas the rest is disposed of. For life cycle stage D in scenario 1, the 2.72 kg of aluminium from ALPOLIC™NC/ALPOLIC™A1 is recycled in the Australian markets and the rest is disposed of. And in case of its packaging, the paper and steel drums are recycled at Mitsubishi's manufacturing unit in Japan. For scenario 2, only 1.36 kg of aluminium is recycled. The mass of outflows is 10.715 kg, which equals the mass of inflows.
Table 4 represents the inflow and outflow calculations for mass balance.

Table 4 Mass balance table

Total weight of the product (Kgs)	Total weight of packaging products (Supplier packaging and final product packaging) Kgs	Total Mass of inflow (Kgs)	Recycling in scenario 1 (Aluminium, steel drum)	Recycling in scenario 2 (Aluminium, steel drum)	Materials disposed in Scenario 1. (Kgs)	Materials disposed in Scenario 2 (Kgs)	Total mass of outflow Kgs
8.68	2.035	10.715	2.729	1.77	7.986	8.945	10.715

4. Life Cycle Impact information

4.1 Life Cycle Impact Indicators

The life cycle impact assessment links the life cycle inventory data to environmental indicators. According to the relevant Product Category Rules (EPD International, 2021), the following environmental impact indicators need to be present for the EPD.

Table 5 Explanation of Life Cycle Impact Indicators

Impact Category Indicator	Unit	Description	Impact Assessment Method
Global Warming Potential – total	kg CO_2 eq.	Climate change can cause adverse effects on ecosystem health, human health, and material welfare. The indicators within this category are related to emissions of greenhouse gases into the air. **Fossil CO_2 eq:** This is defined as greenhouse gases emissions caused due to fossil fuels in Carbon-di-oxide equivalent. **Biogenic CO_2 eq**: This is defined as greenhouse gas emissions caused by the natural carbon cycle. **CO_2 eq from land transformation**: This is defined as Greenhouse emissions caused due to direct or indirect land use by humans.	IPCC 2013 baseline (as part of Environmental Footprint 3.0) (Fazio, et al., 2018)
Global Warming Potential – fossil	kg CO_2 eq.		
Global Warming Potential – biogenic	kg CO_2 eq.		
Global Warming Potential – land use and land use change	kg CO_2 eq.		
Stratospheric ozone depletion potential	kg CFC 11 eq.	Stratospheric ozone depletion can have harmful effects on human health, animal health, terrestrial and aquatic ecosystems, and biochemical cycles. The indicators within this category are related to hydrocarbons containing combined bromine, fluorine and chlorine, and chlorofluorocarbons (CFCs).	WMO (as part of Environmental Footprint 3.0)
Acidification potential	mol H^+ eq.	This category considers acidifying substances that cause a wide range of effects on soil, groundwater, surface water, organisms, ecosystems, and materials.	Accumulated exceedance (as part of Environmental Footprint 3.0)
Eutrophication potential – aquatic freshwater	kg PO eq.	The eutrophication process occurred in the freshwater bodies due to emissions of Phosphorus-containing substances is called freshwater eutrophication.	Accumulated exceedance (as part of Environmental Footprint 3.0)

Eutrophication potential – aquatic marine	kg N eq.	Eutrophication process occurred in the marine water bodies due to emission of Nitrogen containing substance is called as marine water eutrophication.	EUTREND model (as part of Environmental Footprint 3.0)
Eutrophication potential – terrestrial	mol N eq.	Air pollution occurred due to excess atmospheric nitrogen or ammonia deposition is called Terrestrial eutrophication.	EUTREND model (as part of Environmental Footprint 3.0)
Formation potential of tropospheric ozone	kg NMVOC eq.		LOTOS-EUROS model (as part of Environmental Footprint 3.0)
Abiotic depletion potential – non fossil resources[1]	kg Sb eq.	These two indicators belong to the category of depletion of abiotic resources. This category considers the protection of human welfare, human health, and ecosystem health. The indicators within this category are related to the extraction of minerals and fossil fuels due to inputs in the system.	CML (as part of Environmental Footprint 3.0)
Abiotic depletion potential – fossil resources[1]	MJ		CML (as part of Environmental Footprint 3.0)
Water deprivation potential m³ world eq. deprivedWater use is reported as deprivation-weighted water consumption - water deprivation potential (WDP). WDP is in addition to the net use of freshwater resource parameter. AWARE (as part of Environmental Footprint 3.0)Particulate matter emissions[1]	disease incidence	It is mainly formed from gas to particle conversions and chemical interactions with the surrounding atmosphere, causing the particle to grow and/or change composition. An important aspect of fine particulate matter is that it persists in the atmosphere for much longer than coarse particles[i]. inhaling PM can negatively affect human health because these are easily deposited in the respiratory tract and lungs.	Model developed by UNEP-SETAC Task Force on particulate matter (PM) in 2016 (as part of Environmental Footprint 3.0)
Ionizing radiation, human health[2]	kBq U235 eq.	Human health impact caused due to radionuclides	Frischknecht et al 2000 (as part of Environmental Footprint 3.0)
Eco-toxicity, freshwater[1]	CTUe	Comparative Toxic Unit for ecosystems (CTUe) expressing an estimate of the potentially affected	USEtox 2.1 (as part of

		fraction of species (PAF) integrated over time and volume per unit mass of a chemical emitted (PAF m3 year/kg).	Environmental Footprint 3.0)
Human toxicity, cancer[1]	CTUh	Comparative Toxic Unit for human (CTUh) expressing the estimated increase in morbidity in the total human population per unit mass of a chemical emitted (cases per kilogram).	USEtox 2.1 (as part of Environmental Footprint 3.0)
Human toxicity, non-cancer[1]	CTUh	Comparative Toxic Unit for human (CTUh) expressing the estimated increase in morbidity in the total human population per unit mass of a chemical emitted (cases per kilogram).	
Land use impacts[1]	-	Land use is Soil quality index.	LANCA (as part of Environmental Footprint 3.0)

1 The results of this environmental impact indicator shall be used with care as uncertainties on these results are high or as there is limited experience with the indicator.
2 This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Table 6 Explanation of resource Use parameters

Parameters with definition (ISO 21930, 2017)	Methods used in SimaPro (Pre-Sustainability, 2020)
Primary energy resources – Renewable Use as energy carrier (PERE) are (first use) bio-based materials used as an energy source. Hydropower, solar and wind power used in the Technosphere are also included in this indicator" ((MJ, net calorific value))	Cumulative Energy Demand V1.11 The Resource parameters are calculated through SimaPro by using the Cumulative Energy Demand V1.11 method which is based on the method published by Ecoinvent version 2.0 and expanded by PRé Consultants for raw materials. Primary energy resources – Renewable Use as energy carrier is sum of renewable wind, solar, geothermal, Renewable, biomass and Renewable, water.
Primary energy resources – Non-renewable Use as energy carrier (PENRE) - are (first use) materials such as peat, oil, gas, coal, [and] uranium used as an energy source". ((MJ, net calorific value))	

	Cumulative Energy Demand V1.11
Primary energy resources Renewable used as raw materials (PERM), are (first use) bio-based materials used as materials (e.g., wood, hemp, etc.)". ((MJ, net calorific value))	Calculated manually
Primary energy resources Non-renewable used as raw materials (PENRM) are (first use) primary resources such as oil, gas, and coal, used for products (e.g., plastic-based products)". ((MJ, net calorific value))	Calculated manually
Secondary materials, SM, are materials recycled from previous use or waste (e.g., scrap metal, broken concrete, broken glass, plastic, and wood) that are used as a material input from another product system. These include both renewable and non-renewable resources, with or without energy content, depending on the status of the material when it was originally extracted from the environment". (kg)	Recycled Aluminium is considered here.
Renewable secondary fuels, RSF, are renewable materials with an energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g., biomass residue pellets, chipped waste wood)". (MJ, net calorific value)	NA
Non-renewable secondary fuels, NRSF, are non-renewable materials with an energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g., processed solvents, shredded tyres)". (MJ, net calorific value)	NA
Net Fresh Water Use (m3)	Recipe 2016 Mid-point method.

4.1.1 Waste Flows

Waste generated along the whole life cycle production chains is calculated with respect to hazardous waste, non-hazardous waste, and radioactive waste as per the General Programme Instructions. The indicators are reported per declared unit of the products (EPD International , 2021).

The SimaPro method used to calculate the waste flows is the EDIP 2003 method. The non-hazardous waste is calculated by the addition of bulk waste and slag/ash generated per declared unit.

4.1.2 Output Flows

As per General Program Instructions, the output flows are represented by components for reuse (kg), material for recycling (kg), materials for energy recovery (this does not include the energy recovered from the waste incineration process), exported energy (MJ) (recovered energy from exported system), exported energy, thermal (MJ) (recovered energy from thermally exported system). These values are calculated manually.

4.2 Sensitivity Analysis

4.2.1 Sensitivity Analysis A

As discussed in the foreground data, the packaging values are based on assumptions, hence there will be some uncertainty in the results. To characterize this uncertainty, a sensitivity analysis was performed by changing the input values of packaging materials and measuring how much effect packaging materials have on the results.

The value for the mass of packaging materials was increased and decreased by 10% to check the sensitivity in the results.

4.2.2 Sensitivity Analysis B

As the transport distances, can change due to different reasons like weather conditions, traffic, driver's personal choice, etc. The input value for transportation in tonne-km may also change. Hence sensitivity analysis was carried out by increasing and decreasing the input value for transportation distance by 10%.

5. Results

5.1 Life Cycle Impact Results

The impacts have been represented with respect to the life cycle modules and processes. The estimated impact results are only relative statements and are not indicative of the endpoints of the impact categories, exceeding threshold values, safety margins or risks.

The upstream process, which includes raw material extraction, has the highest impact. Module D has a negative impact since the presence of aluminium and packaging materials like recycled steel and paper tend to reduce the burden generally associated with raw material extraction and disposal.

Table 7 shown below lists the environmental impacts of ALPOLIC™NC/ALPOLIC™A1.

The use of recycled aluminium does not add any impacts. Scenario 1 represents the impacts associated with 100% recycling of aluminium while Scenario 2 represents the impacts when only 50% of aluminium is recycled at the end of life.

Table 7 Environmental Impacts for ALPOLIC™NC/ALPOLIC™A1 scenario 1 and Scenario

Impact Indicator	Unit	Upstream Process	Core Process	Downstream Process			Scenario 1 Other Environmental benefits	Scenario 2 Other Environmental benefits
		A1	A2-A3	A4	C1-C2	C3-C4	D	D
Global Warming Potential – total	kg CO_2 eq.	4.83E+01	2.25E+00	4.62E+00	2.61E-01	5.24E-01	-5.41E+01	-2.70E+01
Global Warming Potential – fossil	kg CO_2 eq.	5.01E+01	2.24E+00	4.62E+00	2.61E-01	1.70E-01	-5.40E+01	-2.69E+01
Global Warming Potential – biogenic	kg CO_2 eq.	-1.88E+00	1.21E-02	1.60E-03	6.82E-05	3.54E-01	-1.32E-01	-6.61E-02
Global Warming Potential – land use and land use change	kg CO_2 eq.	1.09E-01	3.51E-04	1.42E-04	2.78E-05	3.03E-06	-2.29E-04	-1.12E-04
Stratospheric ozone depletion potential	kg CFC 11 eq.	2.15E-06	3.27E-07	5.63E-07	4.89E-08	2.77E-08	-1.53E-06	-7.58E-07
Acidification potential	mol H^+ eq.	3.13E-01	7.54E-03	4.48E-02	1.20E-03	5.58E-04	-3.58E-01	-1.79E-01
Eutrophication potential – aquatic freshwater	kg P eq.	1.59E-02	1.03E-04	1.04E-04	1.13E-05	4.20E-06	-1.57E-03	-7.83E-04
Eutrophication potential – aquatic marine	kg N eq.	5.41E-02	2.74E-03	1.80E-02	3.80E-04	1.67E-02	-4.76E-02	-2.38E-02
Eutrophication potential – terrestrial	mol N eq.	5.40E-01	2.72E-02	1.98E-01	4.17E-03	2.07E-03	-5.16E-01	-2.58E-01
Formation potential of tropospheric ozone	kg NMVOC eq.	1.59E-01	8.26E-03	5.10E-02	1.25E-03	3.48E-03	-1.54E-01	-7.71E-02

Abiotic depletion potential – non fossil resources[1]	kg Sb eq.	8.79E-04	1.69E-05	1.09E-05	2.32E-06	1.49E-07	-1.80E-05	-8.97E-06
Abiotic depletion potential – fossil resources[1]	MJ	5.30E+02	3.44E+01	5.13E+01	3.56E+00	1.94E+00	-2.92E+02	-1.46E+02
Water deprivation potential[1]	m^3 world eq. deprived	5.40E+01	5.54E+00	3.44E+01	1.32E+00	6.36E-01	-1.28E+03	-6.42E+02
Particulate matter	disease incidence	3.87E-06	9.31E-08	1.38E-07	1.30E-08	3.81E-09	-4.32E-06	-2.16E-06
Ionising radiation[2]	kBq U235 eq.	1.58E+00	6.82E-02	3.06E-02	5.32E-03	3.46E-04	-2.18E-02	-1.07E-02
Eco-toxicity, freshwater[1]	CTUe	1.66E+03	1.93E+01	3.15E+01	2.18E+00	3.06E+00	-2.62E+02	-1.31E+02
Human toxicity, cancer[1]	CTUh	7.22E-08	5.14E-10	1.13E-09	7.22E-11	2.55E-11	-5.38E-08	-2.69E-08
Human toxicity, non-cancer[1]	CTUh	1.35E-06	1.48E-08	5.81E-08	2.85E-09	1.79E-09	-7.31E-07	-3.66E-07
Land use impacts[1]	-	2.99E+02	9.58E+00	4.14E+01	1.52E+00	3.76E+00	-1.25E+02	-6.23E+01

[1] The results of this environmental impact indicator shall be used with care as uncertainties on these results are high or as there is limited experience with the indicator.

[2] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Table 8 represents additional impacts for ALPOLIC™NC/ALPOLIC™A1. The below results clearly show that the highest impacts are observed in the upstream process. The use of recycled aluminium does not add any impacts.

Table 8 Resource Use Parameters for ALPOLIC™NC/ALPOLIC™A1 scenario 1 and Scenario 2

Impact Indicator		Unit	Upstream Process	Core Process	Downstream Process			Scenario 1 Other Environmental benefits	Scenario 2 Other Environmental ' benefits
			A1	A2-A3	A4	C1-C2	C3-C4	D	D
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	7.25E+01	3.55E-01	6.96E-01	3.74E-02	9.06E-03	-3.40E+01	-1.70E+01
	Used as raw materials	MJ, net calorific value	1.54E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	8.79E+01	3.55E-01	6.96E-01	3.74E-02	9.06E-03	-3.40E+01	-1.70E+01
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	5.30E+02	3.44E+01	5.13E+01	3.56E+00	1.94E+00	-2.92E+02	-1.46E+02
	Used as raw materials	MJ, net calorific value	4.26E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ, net calorific value	5.35E+02	3.44E+01	5.13E+01	3.56E+00	1.94E+00	-2.92E+02	-1.46E+02
Secondary material resources		Kg	1.36E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Renewable secondary fuels		MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels		MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water		m3	1.37E+00	1.30E-01	7.99E-01	3.08E-02	1.48E-02	-2.98E+01	-1.49E+01

Table 9 represents waste flows for ALPOLIC™NC/ALPOLIC™A1 in Scenario 1 and Scenario 2.

Table 9 Waste flows for ALPOLIC™NC/ALPOLIC™A1 scenario 1 and scenario 2

Parameters	Unit	Upstream Process	Core Process	Downstream Process			Scenario 1 Other Environ mental benefits	Scenario 2 Other Environ mental benefits
		A1	A2-A3	A4	C1-C2	C3-C4	D	D
Radioactive Waste	Kg	8.48E-04	6.93E-05	3.63E-05	7.17E-06	2.52E-07	-2.81E-06	-1.40E-06
Hazardous Waste	Kg	1.29E-03	5.88E-05	4.52E-05	5.23E-06	1.01E-06	2.13E-03	1.06E-03
Non-Hazardous Waste	Kg	1.13E+01	6.03E-01	4.66E-01	8.68E-02	1.04E+01	-6.46E+00	-3.23E+00

Table 10 Output flows for ALPOLIC™NC/ALPOLIC™A1 scenario 1 and scenario 2Table 11 represents output flows for ALPOLIC™NC/ALPOLIC™A1 scenario 1 and scenario 2. Since both the aluminium as well as the steel drums used in packaging are recyclable, the material for recycling is 3.178 kgs.

Table 10 Output flows for ALPOLIC™NC/ALPOLIC™A1 scenario 1 and scenario 2

Impact Indicator	Unit	Upstream processes	Core processes	Downstream processes			Scenario 1 Other Environ mental benefits	Scenario 2 Other Environ mental benefits
		A1	A2-A3	A4	C1-C2	C3-C4	D	D
Reuse	kg	0	0	0	0	0	0	0
Materials for recycling	kg	3.17	0	0	0	0	0	0
Energy recovered	MJ	0	0	0	0	0	0	0
Energy exported	MJ	0	0	0	0	0	0	0
Energy exported, thermal	MJ	0	0	0	0	0	0	0

5.2 Interpretation

For climate change, it can be observed that the highest impacts are associated with the upstream processes since they include the use of the raw materials. Namely, the process of casting aluminium coils from aluminium ingots. The other noticeable impacts occur due to the use of aluminium hydroxide and polyurethane foam as packaging material.

The ozone depletion potential is observed to be highest in the core processes, mainly due to the transportation of materials to the manufacturing location and the actual manufacturing of the final product. The use of heat energy to produce 1m2 of ALPOLIC™NC/ALPOLIC™A1 has more of an impact than the use of electricity.

Among the downstream processes, the impacts associated with sea transport is quite high.

If the aluminium is recycled, the overall impacts in land use, human toxicity - cancerous and human non-cancerous parameters can be substantially decreased.

Recycling aluminium at the end of the life lowers the life cycle impact of the product except in the case of the hazardous waste flow indicator. Recycling of Aluminium may cause more hazardous waste flows due to chemicals or heavy metals used in the end of the life treatments or during the manufacture the product.

5.3 Recommendation

A proper take-back scheme provided by the distributor will ensure that maximum recycling of aluminium takes place. Distributors can then collaborate with resource recovery facilities to appropriately recycle the product. The impacts of Module 4 in stage 1 – transportation from Mitsubishi Chemicals Infratec's factory in Japan to Network Architectural facility in Australia, can be reduced if Mitsubishi directly transports the products to the construction site. Though this can vary highly with each contract. Packaging materials like polyurethane foam should be reused or alternative material should be used to lower the impacts of the upstream processes.

5.4 Sensitivity Analysis

Table 11 and Table 12 show the sensitivity of the total impacts to variation in packaging materials and transportation distances. Since the packaging values are based on assumptions, there will be some uncertainty in the results. Table 11 illustrates the results of the sensitivity analysis. The value for the mass of packaging materials was alternatingly increased and decreased by 10% to check its effect on the results. Sensitivity Analysis 1 represents the results of decreasing the quantity of packaging by 10 % and Sensitivity Analysis 2 represents the results of increasing the quantity of packaging by 10%.

If the packaging materials are changed by 10% (either increased or decreased), the change in output flows varies with respect to parameters. The difference is highest in Acidification Potential (mol H+ eq). When the packaging input values are increased/decreased by 10%, the value of acidification potential
30
increases/decreases by 43%. The other highly sensitive parameters are +/-17% for CO2 Fossil; +/-30% for CO2 Overall GWP; and +/- 8% for particulate matter (disease inc.).

Table 11 Sensitivity Analysis for packaging materials

Impact Indicator	Unit	Sensitivity Analysis 1	Actual Value	Sensitivity Analysis 2
Global Warming Potential – total	kg CO_2 eq.	1.45E+00	2.06E+00	2.66E+00
Global Warming Potential – fossil	kg CO_2 eq.	2.99E+00	3.59E+00	4.20E+00
Global Warming Potential – biogenic	kg CO_2 eq.	-1.65E+00	-1.65E+00	-1.65E+00
Global Warming Potential – land use and land use change	kg CO_2 eq.	1.09E-01	1.09E-01	1.09E-01
Stratospheric ozone depletion potential	kg CFC 11 eq.	1.54E-06	1.62E-06	1.70E-06
Acidification potential	mol H^+ eq.	5.80E-03	1.01E-02	1.44E-02
Eutrophication potential – aquatic freshwater	kg P eq.	1.46E-02	1.46E-02	1.46E-02
Eutrophication potential – aquatic marine	kg N eq.	4.30E-02	4.47E-02	4.63E-02
Eutrophication potential – terrestrial	mol N eq.	2.39E-01	2.58E-01	2.76E-01
Formation potential of tropospheric ozone	kg NMVOC eq.	6.52E-02	7.00E-02	7.49E-02
Abiotic depletion potential – non fossil resources	kg Sb eq.	8.91E-04	8.93E-04	8.94E-04
Abiotic depletion potential – fossil resources	MJ	3.24E+02	3.32E+02	3.39E+02
Water deprivation potential	m^3 world eq. deprived	-1.19E+03	-1.19E+03	-1.18E+03
Particulate matter	disease incidence	-1.99E-07	-1.84E-07	-1.69E-07
Ionising radiation	kBq U235 eq.	1.66E+00	1.66E+00	1.67E+00
Eco-toxicity, freshwater	CTUe	1.46E+03	1.46E+03	1.46E+03
Human toxicity, cancer	CTUh	2.00E-08	2.01E-08	2.03E-08
Human toxicity, non-cancer	CTUh	6.94E-07	7.00E-07	7.06E-07
Land use impacts	-	2.27E+02	2.31E+02	2.35E+02
Primary energy resources – Renewable	Use as energy carrier. (MJ, net calorific value)	3.61E+01	3.88E+01	4.15E+01
	Used as raw materials.	1.36E+01	1.54E+01	1.65E+01

	(MJ, net calorific value)			
	TOTAL	4.97E+01	5.42E+01	5.80E+01
Primary energy resources – Non-renewable	Use as energy carrier. (MJ, net calorific value)	3.62E+02	3.72E+02	3.81E+02
	Used as raw materials. (MJ, net calorific value)	3.83E+00	4.26E+00	4.69E+00
	TOTAL	3.66E+02	3.76E+02	3.86E+02
Secondary material resources	Kg	1.36E+00	1.36E+00	1.36E+00
Renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Non-renewable secondary fuels	MJ, net calorific value	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water	m3	-2.76E+01	-2.76E+01	-2.75E+01
Waste Flow				
Radioactive Waste	Kg	9.47E-04	9.51E-04	9.54E-04
Hazardous Waste	Kg	5.09E-03	5.09E-03	5.09E-03
Non-Hazardous Waste	Kg	1.68E+01	1.68E+01	1.69E+01

6. Comparison

The estimated impact results are only relative statements that do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins, or risks. ALPOLIC™NC/ALPOLIC™A1 was compared to SARAY, another Aluminium Composite Panel with an existing EPD. SARAY Al Composite Panels consist of a white-coloured low-density polyethylene and mineral core bonded between two Aluminium panel sheets. Aluminium sheets can be coated with polyvinylidene difluoride (PVDF) or polyester paint. The product consists of 20-30% Aluminium, 40-65% mineral filler, 0.5-4% adhesive, 9-20% polyethylene filler, 1% polyester coating, and 1% PVDF coating. The total weight of the product is 9.5 kg per m2. SARAY's LCA was modelled with SimaPro 8.2 LCA software using the impact factors and the latest version of the Ecoinvent database v3.02 for secondary data and Turkish Life Cycle Inventory Database (TLCID) (SARAY, 2016). This comparison was only made for modules A1, A2, A3, C4, and D as per results provided by SARAY's EPD.

Table 12 Comparison with other product ALPOLIC™NC/ALPOLIC™A1 VS SARAY

Impact Indicator	UNIT	ALPOLIC™NC/ ALPOLIC™A1	SARAY	% Difference
Global warming (GWP100a)	kg CO2 eq	3.24E+00	3.85E+01	-91.6%
Ozone layer depletion (ODP)	kg CFC-11 eq	1.46E-06	1.27E-06	15.7%
Acidification	kg SO2 eq	1.85E-01	1.23E-02	1397.2%
Eutrophication	kg PO4--- eq	6.82E-02	1.96E-01	-65.2%
Photochemical oxidation	kg C2H4 eq	6.27E-03	7.15E-02	-91.2%
Abiotic depletion	kg Sb eq	8.90E-04	1.23E-04	622.8%
Abiotic depletion (fossil fuels)	MJ	2.98E+02	4.32E+02	-31.1%

7. References

ISO 21930. (2017). ***Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.*** International Organization for Standardization.

Alucolink. (2020). ***How to recycled aluminium composite panels***. Retrieved 04 04, 2021

Castaldi, D. A., & J., M. (2016). ***Determining accurate heating values of non-recycled plastics***. New York: Earth Engineering Center, City University of New York.

*E*N 15804:2012+A2:2019. (2020). ***Sustainability of construction works – EN 15804:2012+A2:2019.*** *German: Sustainability of construction works.*

EPD International . (2021). ***General Programme instructions Version 3.01.*** *The International EPD Systems. Envirodec.*

Fazio, S., Biganzioli, F., De Laurentiis, V., Zampori, L., Sala, S., & Diaconu, E. (2018). ***Supporting information to the characterisation factors of recommended EF Life Cycle Impact Assessment methods.*** European Commission.

ISO 14025. (2006). ***Environmental management -Life cycle assessment – Principles and framework.*** Insternational Standard Organisation.

ISO 14040. (2006). ***Environmental management -Life cycle assessment – Principles and framework.*** International Organization for Standardization.

ISO 14044. (2016). ***Environmental management –Life cycle assessment – Requirements and guidelines.*** International Organization for Standardization.

Pongrácz, E (2007). Environmental Impact of Packaging. In book: Environmentally Conscious Materials and Chemicals Processing (pp.237 - 278). Retrieved from Doi: 10.1002/9780470168219.ch9

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. (2015). ***Wood Fuels Handbook***. United Nations.

Pre-Sustainability. (2020). ***SimapPro Database Manual.*** Methods Library.

SARAY. (2016). ***Environmental Product Declaration SARAY.*** Turkey: The international EPD system.

SimaPro . (2019). ***Ecoinvent v3*.**

8. Appendix

8.1 Assumptions

8.1.1 Restriction with Module A4 and A5:

Module A4 is an optional module present in the scope 'Cradle to Gate with End of Life and Options'. Module A4 should be transportation from the manufacturer's location to the construction site. In this study, module A4 has two stages- Stage-1 Transportation from Mitsubishi Chemicals Infratec's factory in Japan to Network Architectural facility in Australia. Stage 2- Network Architectural facility in Australia to the construction site. As the construction sites would vary around Australia, this is not part of the study and only Stage-1 is taken into consideration for module A4.

Module A5 is an optional module that is not included in this study. The module represents impacts from the installation of the product at the construction site. Neither Mitsubishi nor its distributor is involved in the construction activity, so the data of installation at the construction site was restricted.

8.1.2 Packaging Assumption and Restrictions:

The amount of packaging, especially from the suppliers, is not in Mitsubishi's control. As the exact value of packaging materials can easily vary, an assumption was made that packaging materials are 9% of the total weight of the materials. For instance, Packaging material for Calcium carbonate is a Polypropylene bag, but since the exact quantity is unknown, it is assumed that the weight of the Polypropylene bag is 9% of the total weight of calcium carbonate. (Pongrácz, 2007). Table 13 present packaging materials quantity.

Table 13 Packaging Materials- quantity

Product Name & Packaging Material	Amount of the product (Kg)	Amount of Packaging- 9% of the amount of the product (Kg)
Calcium Carbonate-Polypropylene Bag	1.17	0.105
Primer- Steel Drum	0.03	0.0027
Paint- Steel Drum	0.08	0.0072
Thermoplastic resin- Paper	0.25	0.00225
Methyl methacrylate (MMA)-Paper	0.02	0.0018
Final Product- Polyurethane foam	8.6	0.774

8.1.3 End of the Life- 'Recycling' Assumption

For Module D, end of the life assumptions are made in order to list the environmental benefits of recycling. It was assumed in Scenario 1 that 100% aluminium is recycled and in Scenario 2 only 50% of aluminium is recycled.

8.1.4 End-of-the-Life 'Waste Transport to Resource Recovery Facility or Sanitary Landfill' Assumption.

It is assumed that the resource recovery site is located about 100kms from the construction site. When the product reaches its end of life stage, it is manually deconstructed and transported to the resource recovery facility. The same assumption of 100km distance is made for the transportation of supplier packaging waste at Mitsubishi Chemicals Infra's facility in Japan.

8.2 Calculations for Transport Distances

Table 14 represents the calculation of inputs for the transport of materials from the supplier to the manufacturer. Data on transport was calculated for an average load factor including empty return trips, using Ecoinvent 3.6 database cut-off criteria and AusLCI database V1.36.

Based on mass (kg).

Table 14 Calculation of transport distances

Ingredients	Quantity [kg]	Transport distance [km]	One tonne of goods over one kilometre [t km]
A2: Ingredients transportation to manufacturing factory			
Aluminium	2.72	275	0.748
Thermoplastic Resin (PVB)	0.25	321	0.082
Aluminium tri-hydroxide	4.41	151	0.666
Calcium Carbonate	1.17	241	0.282
Additives (MMA)	0.02	161	0.003
Primer (Epoxy)	0.03	151	0.001
Coatings	0.08	157	0.016
A4: Final Product Transport to the Distributers- (Mitsubishi Chemicals Infratec Factory in Japan to Network Architectural in New South Wales- Australia)			
Mitsubishi Chemicals Infratec Factory to Port in Japan- Road Transport	10.17	263	2.675
Port in Japan- Port in Australia (NSW)	10.17	8104.35	82.453
Port in Australia (NSW) to Network Architectural (Revesby, NSW)	10.17	20	0.203

8.3 Calculations for Resource Use

The net calorific value (NCV) of oven-dry wood of different species varies within a very narrow interval of 18.5 to 19 MJ per Kg (NATIONS, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED, 2015). The wooden packaging box is considered to weigh 0.8kgs. The net calorific value of this wooden box is 19*0.8 MJ=15.4 MJ. This provides a 'Primary energy resources – Renewable' used as raw material.

The net calorific value of PP is 40.8 MJ per Kg (Castaldi & J., 2016). The weight of plastic packaging film is 0.1053. Hence NCV of LDPE is 4.26 MJ. This provides a 'Primary energy resources - non-Renewable' used as raw material.

Mitsubishi Chemical Infratec Co., Ltd.
info@alpolic.jp
www.alpolic.com
+81-(0)3-6748-7348

Network Architectural.
71-75 Marigold Street, Revesby, NSW, 2212, Australia
www.networkarchitectural.com.au
(02) 8316-5000

MITSUBISHI CHEMICAL

MITSUBISHI CHEMICAL INFRATEC CO.,LTD.

ALPOLIC™