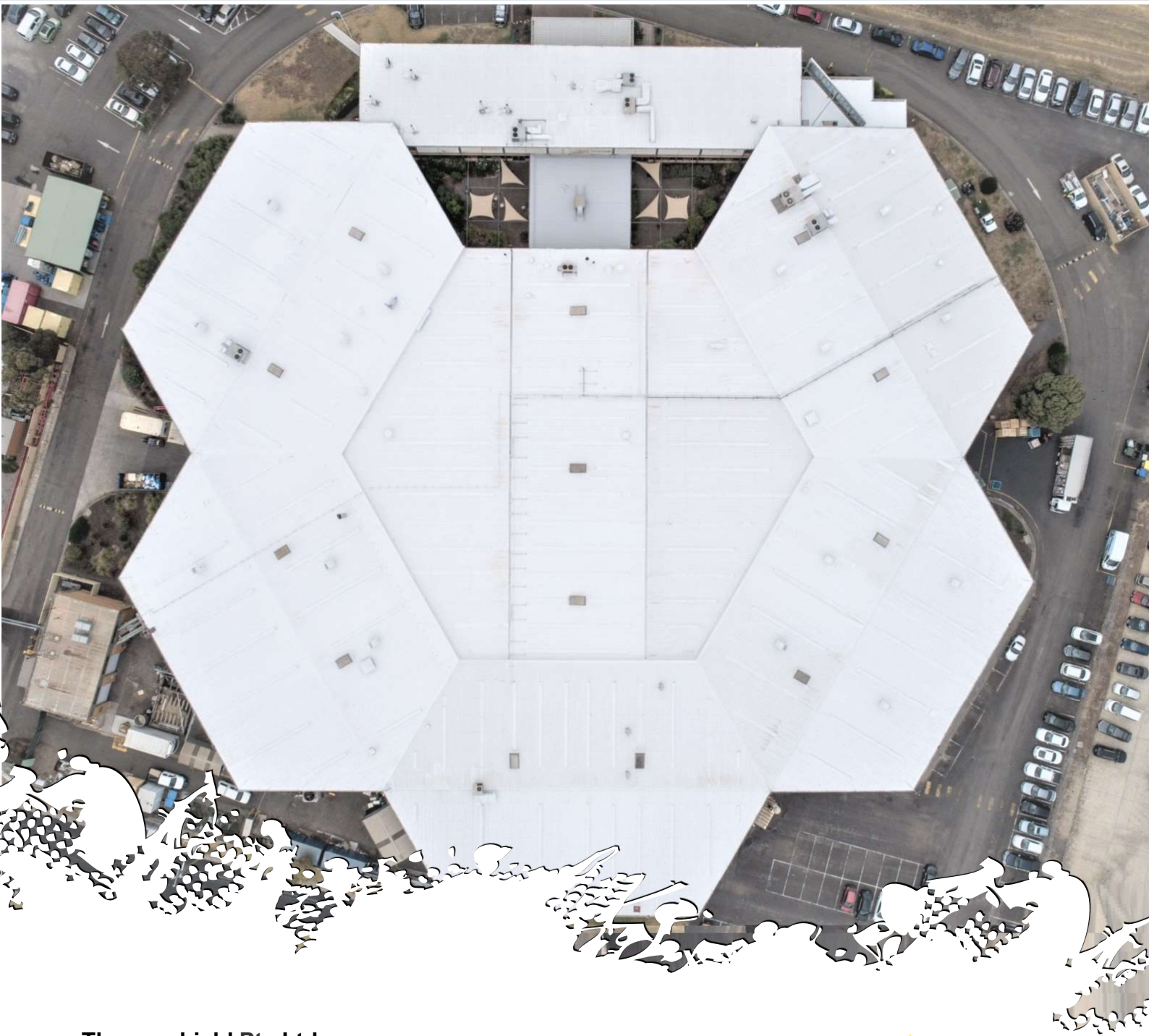




# EPD<sup>TM</sup>

Environmental Product Declaration

Global GreenTag EPD Program:  
Compliant to EN ISO 14025:2010



**Thermoshield Pty Ltd**  
**Thermoshield Radiant Barrier Coatings**  
P.O. Box 16 Silvan Victoria 3795 Australia



**Mandatory Disclosures**

<b>EPD type</b>	Cradle to grave A1 to C4	<b>EPD Number</b>	TSD SD01 2022EP
<b>Issue Date</b>	15 December 2022	<b>Valid Until</b>	15 December 2025
<b>Demonstration of Verification</b>			
<b>PCR</b>	Product Category Rules (PCR) 221207_PCR_THI Thermal Insulation applies [1].		
<input checked="" type="checkbox"/> <b>Internal</b>	 16 December 2022	LCA Developed by Delwyn Jones, The Evah Institute	
	 16 Dec 2022	LCA Reviewed by Direszni Naiker Ecquate Pty Ltd	
	 20/12/2022	EPD Reviewed by David Baggs, Global GreenTag Pty Ltd	
<input checked="" type="checkbox"/> <b>External</b>	 15-12-2022	Third Party Verifier <sup>a</sup> Mathilde Vlieg Malaika LCT	
<b>Communication</b>	a. Independent external verification of the declaration and data, mandatory for business-to-consumer communication according to ISO 14025:2010 [2]. This EPD discloses potential environmental outcomes compliant for business-to-business communication.		
<b>Comparability</b>	Product EPDs may not be comparable if not compliant. Different program EPDs may not be comparable. Comparability is further dependent on the product category rules and data source used.		
<b>Reliability</b>	LCIA results are relative expressions that do not predict impacts on category endpoints, exceeding of thresholds, safety margins or risks.		
<b>Owner</b>	This EPD is the property of the declared manufacturer.		
<b>Explanations</b>	Further explanatory information is available at <a href="mailto:info@globalgreentag.com">info@globalgreentag.com</a> or by contacting <a href="mailto:certification1@globalgreentag.com">certification1@globalgreentag.com</a> [3].		

<b>EPD Program Operator</b>	<b>LCA and EPD Producer</b>	<b>Declaration Owner</b>
Global GreenTag Pty Ltd PO Box 311 Cannon Hill QLD 4170 Australia Phone: +61 (0)7 33 999 686 <a href="http://www.globalgreentag.com">http://www.globalgreentag.com</a>	Ecquate Pty Ltd PO Box 123 Thirroul NSW 2515 Australia Phone: +61 (0)7 5545 0998 <a href="http://www.evah.com.au">http://www.evah.com.au</a>	Thermoshield Pty Ltd P.O Box 16 Silvan VIC 3795 Australia Phone +61 (0)3 9728 8800 <a href="https://www.thermoshield.com.au">https://www.thermoshield.com.au</a>



### Program Description

<b>EPD Scope</b>	Cradle to grave A1 to C4 as defined by EN 15804 [3]																		
<b>System boundary</b>	The system boundary with nature includes material and energy acquisition, processing, manufacture, transport, installation plus waste arising to end of life.																		
<b>Stages included</b>	Operations A1 to C4																		
<b>Stages excluded</b>	No operation was excluded but no flows arose in modules B4, B5, B6, B7 and C3.																		
<b>Information Modules</b>	Figure 1 depicts all modules being declared including some with zero results. Any module not declared (MND) does not indicate a zero result.																		
<b>Model Information</b>	<b>Actual</b> Building Life Cycle Assessment												<b>Scenarios</b> Potential Supplementary						
<b>Stages</b>	Product			Construct		Use							End-of-Life				Benefit & load beyond system		
<b>Modules</b>						Fabric			Operation										
<b>Unit Operations</b>	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3
<b>Cradle to grave phases</b>	Resources	Transport	Manufacture	Transport	Construct	Use	Maintain	Repair	Replace	Refurbish	Energy use	Water use	Demolish	Transport	Process Waste	Disposal	Reuse	Recovery	Recycling

Figure 1 EPD Life Cycle Modules Cradle to Grave

### Data Sources

<b>Primary Data</b>	Data is from primary sources 2017 to 2022 including the manufacturer and suppliers' standards, logistics, technology, market share, management system in accordance with EN ISO 14044:2006, 4.3.2 [4]. All are physically allocated not economically allocated.
<b>A1-A3 Stage inclusions</b>	Operations include all known raw material acquisition, refining and processing plus scrap or material reuse from prior systems; electricity generated from all sources with extraction, refining & transport plus secondary fuel energy and recovery processes. Also, transport to factory gate; manufacture of inputs, ancillary material, product, packaging, maintenance, replacement plus flows leaving at end-of-waste boundary and fates of all flows at end of life.
<b>Variability</b>	Significant differences of average LCIA results are declared.
<b>Chemicals of Concern</b>	Contains no substances in the European Chemicals Agency "Authorised or Candidate Lists of Substances of Very High Concern (SVHCs)".

### Data Quality

Data cut-off & quality criteria complies with EN 15804 [1] The LCA used background data aged <10 years and quality parameters tabled below.

Background	Data Quality	Parameters and Uncertainty (U)			
<b>Correlation</b>	<b>Metric <math>\sigma</math></b>	U $\pm$ 0.01	U $\pm$ 0.05	U $\pm$ 0.10	U $\pm$ 0.20
<b>Reliability</b>	<b>Reporting</b>	Site Audit	Expert verify	Region	Sector
	<b>Sample</b>	>66% trend	>25% trend	>10% batch	>5% batch
<b>Completion</b>	<b>Including</b>	>50%	>25%	>10%	>5%
	<b>Cut-off</b>	0.01%w/w	0.05%w/w	0.1%w/w	0.5%w/w
<b>Temporal</b>	<b>Data Age</b>	<3 years	$\leq$ 5 years	<7.5 years	<10 years
	<b>Duration</b>	>3 years	<3 years	<2 years	1 year
<b>Technology</b>	<b>Typology</b>	Actual	Comparable	In Class	Convention
<b>Geography</b>	<b>Focus</b>	Process	Line	Plant	Corporate
	<b>Range</b>	Continent	Nation	Plant	Line
	<b>Jurisdiction</b>	Representation is Global. Africa, North America, Europe, Pacific Rim			

## Product Information

This section provides data required to calculate assessment results factoring different mass and periods.

<b>Brand Name &amp; Code</b>	Thermoshield Liquid Thermal Insulation
<b>Factory warranty</b>	10 years external use
<b>Manufacturer, address and site representation</b>	Made in 11/42 Mills Rd, Dandenong Victoria 3175 since 1997 by Thermoshield Australia Pty Ltd, an Australian owned and operated company
<b>Quality Control</b>	The factory operates under management systems certified compliant to ISO-9001 for Quality Control and continuous improvement. Company sites are also certified compliant to ISO 14001 and environmental improvement.
<b>Application</b>	Coating for commercial buildings, industrial gear, homes, trucks and silos
<b>Function in Building</b>	It reduces heat transfer to indoor space so indoors are cooler in summer and warmer in winter avoiding additional heating and cooling
<b>Lifetime [5,6]</b>	10 years Reference Service Life (RSL) [ISO 15686]
<b>Declared unit</b>	500 grams/m <sup>2</sup> Thermoshield Liquid Thermal Insulation coating
<b>Functional unit</b>	20 years use of 500gsm Thermoshield Liquid Thermal Insulation

## Product Components

This section summarises factory components, functions, source nation and % mass share. In product content listed below the % mass has a  $\pm 5\%$  range and a confidence interval that is 90% certain to contain true population means at any time. Listing such  $90\pm 5\%$  certainty considers normal resource acquisition, supply chain, sedimentation, seasonal, manufacturing and product colour variation over this EPD's validity period. This also allows for intellectual property protection whilst ensuring fullest possible transparency.



**Fig. 2 Packaging**

Function	Component	Source	Amount
<b>Vehicle</b>	Deionised Water	Victoria	>40<50
<b>Binder</b>	Acrylic Copolymer	Australia	>20<30
<b>White Fill</b>	Powdered Limestone	Australia	$\geq 10 < 20$
<b>Pigment</b>	Titanium Dioxide	Australia	$\geq 5 < 10$
<b>Rust Inhibitor</b>	Zinc Phosphate	Victoria	$\geq 4 < 10$
<b>Insulation</b>	Glass Beads	Victoria	$\geq 3 < 10$
<b>Carrier</b>	Ester Alcohol	USA	$\geq 1.5 < 5$
<b>Emulsifier</b>	Polypropylene Glycol	Victoria	$\geq 1.0 < 2$
<b>Thickener</b>	Sodium Acrylate	UK	$\geq 1.0 < 2$
<b>Preservative</b>	Proprietary Fungicide	NSW	$\geq 0.5 < 1$
<b>Thickener</b>	Hydroxyethyl Cellulose	Victoria	$\geq 0.2 < 1$
<b>Antioxidant</b>	Ammonia	NSW	$\geq 0.1 < 1$
<b>Defoamer</b>	Silicones	UK	$\geq 0.1 < 1$
<b>Packing</b>	The product is packaged as depicted in Figure 2.		
<b>Pail &amp; Lid</b>	Polypropylene	Australia	>0.6 <0.7
<b>Wrapping</b>	Polyethylene	Australia	>0.5 <0.7
<b>Pallets</b>	Wood	Australia	>0.5 <0.6
<b>Strapping</b>	Polypropylene	Australia	>0.2 <0.4

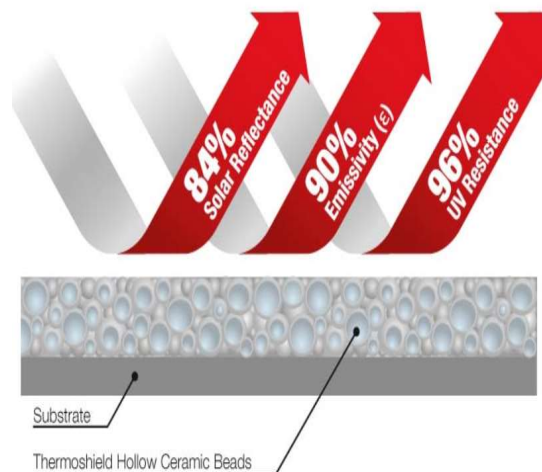
There are significant synergies and contribution from components serving multiple functions with

- All Zinc compounds serving as anti-corrosive, biocides, pigments and recycles plus;
- Hollow glass beads serving as insulators, reflectors, pigments, extenders and recycles;
- Low impact transport with short land distance and long-haul sea freight rather than vice versa;
- High local content in quality inputs alongside imports from EU and China of complex chemicals and
- Advanced high-end technology with Australian-made Q cels and overseas made biocides.

**Product Functional & Technical Performance Information**

This section provides manufacturer specifications and additional information

<b>Specifications</b>	The specified Thermoshield coating thickness is 500 µm. Advice and information. is available at <a href="http://www.thermoshield.com.au">www.thermoshield.com.au</a> .
<b>Installation Procedure</b>	Its hollow ceramic beads acts as insulation as depicted in Figure 3 Solar reflectance. Reduced environmental impact longer term arises from the:
<b>Practicality</b>	<ul style="list-style-type: none"> <li>• Anti-corrosives to protect and extend the building and infrastructure life</li> <li>• Greener fungicides reducing reliance on toxic conventional biocides.</li> </ul>
<b>Fire Classification</b>	Group 1 in accordance with AS 5637.
<b>Durability</b>	Long-term corrosion inhibitors protect metal cladding edge and substrate As the coating weathers, corrosion inhibitors protect the substrate. Rain washing provides free maintenance service. After 10 years recoating is recommended after a wash-down and sanding to remove debris. So, no additional use, maintenance and disposal phase operations are required or included in this declaration. The original coating continues to contribute its insulating value.
<b>Thermal Performance</b>	<p>Thermoshield 500gsm client testimonials indicate a typical 20% annual building energy and hence greenhouse gas savings with Thermoshield. There is compelling evidence of longer term reduced environmental impact from use of the:</p> <ul style="list-style-type: none"> <li>• Barrier coating and improved thermal performance with higher heat reflectance and lower gain;</li> <li>• Lower energy costs with improved thermal performance from the higher insulation value coating;</li> <li>• Lower Carbon footprint with reduced energy use from the coating's higher insulation values and</li> <li>• Avoided life cycle energy use reducing greenhouse gas impact and less induced climate change.</li> </ul>



**Figure 3 Solar reflectance 84%**

Further study is underway to model the operational savings in energy and carbon over the building operating life for the 10 years of the coating design life compared to uncoated buildings.

### System Analysis Scope and Boundaries

Figure 4. shows included processes in a cradle to grave system boundary to end of life fates reuse, recycling, or landfill grave beyond the boundary. Stages A1 to 3 model actual operations. Stage A4 to C4 are scenarios.

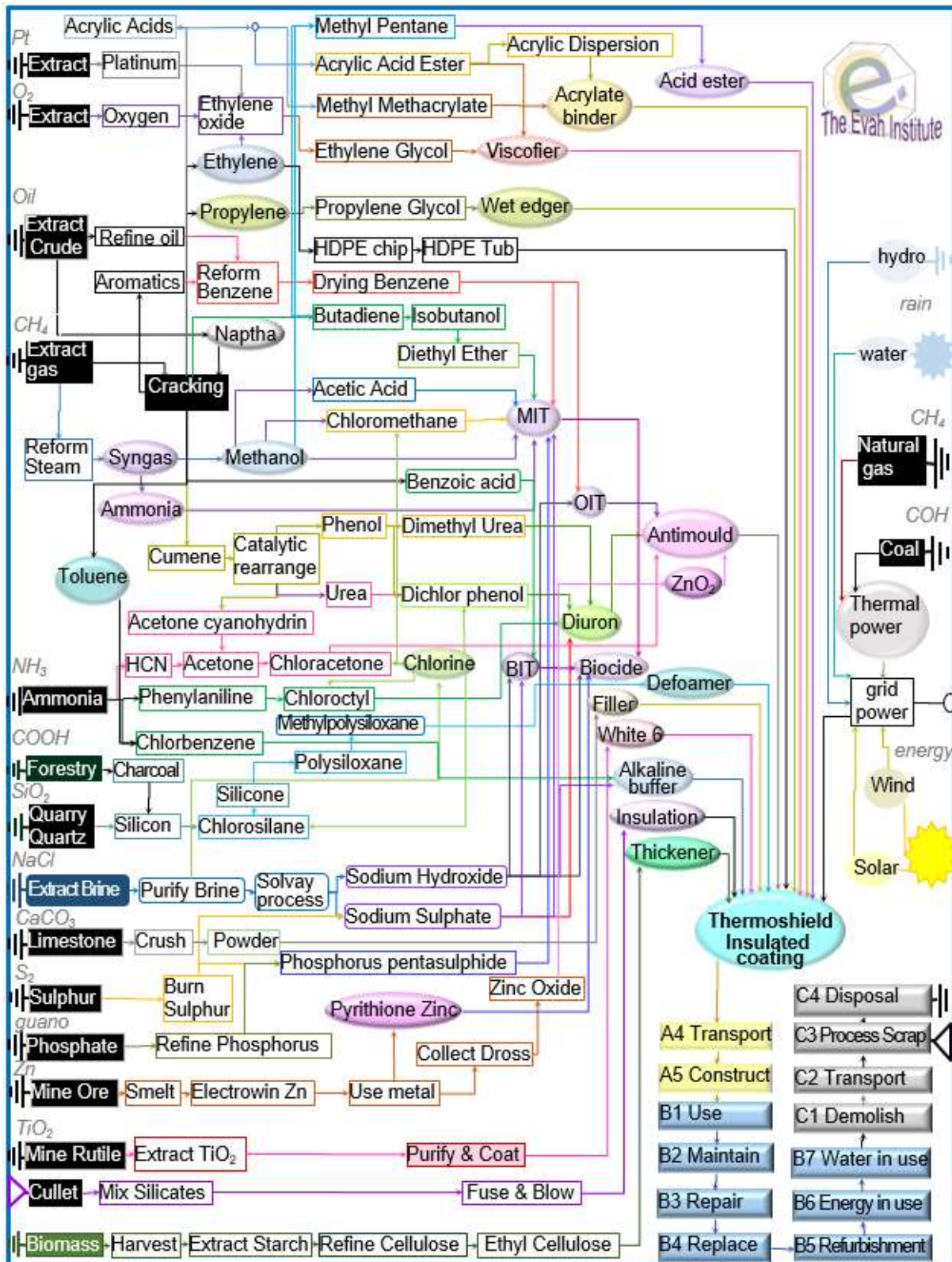


Figure 4. Product Process Flow Chart

## Environmental Impact Terminology

Environmental impacts contributing to risks of social and ecological issues and collapse are tabled below with common names and remedies given for each indicator.

<p><b>Global warming forcing Climate Change</b></p>	<p>Greenhouse gases absorb infra-red radiation. This heat reduces thermal energy differentials, from equator to poles, forcing ocean current and wind circulation to blend and regulate climate. Weakly blended “lumpier” weather has more frequent, extreme heat wave, fire-storm, cyclone, rain-storm, flood and blizzard events. Accumulation of carbon dioxide, natural gas methane, nitrous oxides and volatile organic compounds from burning fossil fuels causes global warming. Forest and wilderness growth absorbing air-borne carbon in biomass can drawdown such accumulation. Urgent renewable energy reliance is vital in time to avoid imminent tipping points and the worsening “<b>climate emergency</b>”.</p>
<p><b>Ozone layer depletion</b></p>	<p>Stratospheric ozone loss weakens the planet’s solar shield so more shorter wavelength ultraviolet (UVB) light reaching earth damages plants and increases malignant melanoma and skin cancer in humans and animals. Chlorofluorocarbons, hydrochlorofluorocarbons (HCFC), chlorobromomethane, hydrobromofluorocarbons, carbon tetrachloride, methyl chloroform, methyl bromide and halon gas cause ozone layer loss. To repair the “<b>ozone hole</b>” reliance on ozone-safe refrigerants, aerosols and solvents is essential to avoid further its depletion and enable accumulation of naturally-formed ozone.</p>
<p><b>Acidification</b></p>	<p>Acidification reduces soil and waterway pH, impedes nitrogen fixation vital for plant growth and inhibits natural decomposition. It increases rates and incidence of fish kills, forest loss and deterioration of buildings and materials. Chief synthetic causes of “<b>acid rain</b>” are emissions of sulphur and nitrogen oxides, hydrochloric and hydrofluoric acids and ammonia from burning fossil fuels polluting precipitation of rain and snow world-wide.</p>
<p><b>Eutrophication of terrestrial, freshwater and marine life</b></p>	<p>Eutrophication from excessively high macronutrient levels added to natural waters promotes excessive plant growth that severely reduces oxygen, water and habitat security for aquatic and terrestrial organisms across related ecosystems. Chief synthetic cause of “<b>algal blooms</b>” is nitrogen (N, NO<sub>x</sub>, NH<sub>4</sub>) and phosphorus (P, PO<sub>4</sub><sup>3-</sup>) in rain run-off over-fertilised land catchments.</p>
<p><b>Photochemical ozone creation</b></p>	<p>Tropospheric photochemical ozone, called “<b>summer smog</b>” near ground level, is created from natural and synthetic compounds in UV sunlight. Low concentration smog damages vegetation and crops. High concentration smog is hazardous to human health. Chief synthetic causes are nitrogen oxides, carbon monoxide and volatile organic compounds (VOC) pollutants. Avoiding reliance on dirtiest coal fuel and volatile chemicals has reduced smog incidence in many areas globally.</p>
<p><b>Depletion of minerals, metals &amp; water</b></p>	<p>Abiotic depletion of finite mineral resources increases time, effort and money required to obtain more resources to the point of extinction of naturally viable reserves. This can limit access to available, valuable and scarce elements vital for human-life. The youth movement “<b>extinction rebellion</b>” calls on adults to secure climate, reserves and biodiversity for current and future generations.</p>
<p><b>Depletion of fossil fuel reserves</b></p>	<p>Abiotic depletion of resources by consuming finite oil, natural gas, coal and yellowcake fossil fuel reserves leaves current and future generations suffering limited available, accessible, plentiful, essential valuable as well as scarce raw material, medicinal, chemical, feedstock and fuel stock. Approaching “<b>peak oil</b>” acknowledged fossil fuel reserves are finite and the need for decision-makers to act to avoid market instability, insecurity and or oil and gas wars.</p>

## Glossary of Terms, Methods and Units

Impact Potentials	Description of Methods	Units
<b>Biogenic Global Warming Potential (GWP)</b>	GWP biogenic [7]	kg CO <sub>2eq</sub>
<b>Land use change GWP</b>	GWP land use & change [7]	kg CO <sub>2eq</sub>
<b>Fossil Fuelled GWP</b>	GWP fossil fuels [7]	kg CO <sub>2eq</sub>
<b>Total GWP</b>	Gross GWP [7]	kg CO <sub>2eq</sub>
<b>Stratospheric Ozone Depletion</b>	Stratospheric Ozone Loss [8]	kg CFC <sub>11eq</sub>
<b>Photochemical Ozone Creation</b>	Summer Smog [9]	kg NMOC <sub>eq</sub>
<b>Acidification Potential</b>	Accumulated Exceedance [10]	mol H <sup>+</sup> <sub>eq</sub>
<b>Eutrophication Freshwater</b>	Excess nutrients freshwater [11]	kg P <sub>eq</sub>
<b>Eutrophication Marine</b>	Excess marine nutrients [11]	kg N <sub>eq</sub>
<b>Eutrophication Terrestrial</b>	Excess Terrestrial nutrients [11]	mol N <sub>eq</sub>
<b>Mineral &amp; Metal Depletion</b>	Abiotic Depletion minerals [12]	kg Sb <sub>eq</sub>
<b>Fossil Fuel Depletion</b>	Abiotic Depletion fossil fuel [13]	MJ <sub>ncv</sub>
<b>Water Depletion</b>	Water Deprivation Scarcity [14, 15]	m <sup>3</sup> <sub>WDP eq</sub>
<b>Inventory Input</b>		
<b>Fresh Water Net</b>	Lake, river, well & town water	m <sup>3</sup>
<b>Secondary Material</b>	Post-consumer recycled (PCR)	kg
<b>Secondary Renewable Fuel</b>	PCR biomass burnt	MJ <sub>ncv</sub>
<b>Primary Energy Renewable Material</b>	Biomass retained material	MJ <sub>ncv</sub>
<b>Primary Energy Renewable Not Feedstock</b>	biomass fuels burnt	MJ <sub>ncv</sub>
<b>Primary Energy Renewable Total</b>	Biomass burnt + retained	MJ <sub>ncv</sub>
<b>Secondary Non-renewable Fuel</b>	PCR fossil-fuels burnt	MJ <sub>ncv</sub>
<b>Primary Energy Non-renewable Material</b>	Fossil feedstock retained	MJ <sub>ncv</sub>
<b>Primary Energy Non-renewable Not Feedstock</b>	fossil-fuel used or burnt	MJ <sub>ncv</sub>
<b>Primary Energy Non-renewable Total</b>	Fossil feedstock & fuel use	MJ <sub>ncv</sub>
<b>Inventory Output</b>		
<b>Hazardous Waste Disposed</b>	Reprocessed to contain risks	kg
<b>Non-hazardous Waste Disposed</b>	Municipal landfill facility waste	kg
<b>Radioactive Waste Disposed</b>	Mostly ex nuclear power stations	kg
<b>Components For Reuse</b>	Product scrap for reuse as is	kg
<b>Material For Recycling</b>	Factory scrap to remanufacture	kg
<b>Material For Energy Recovery</b>	Factory scrap use as fuel	kg
<b>Exported Energy Electrical</b>	Uncommon for building products	MJ <sub>ncv</sub>
<b>Exported Energy Thermal</b>	Uncommon for building products	MJ <sub>ncv</sub>



## Module A1 to C4 Results

Table 1 shows results from A1 to C4 Cradle to grave at end-of-life.

**Table 1a A1 to C4 Impact Results/Functional Unit**

Result	Units	A1 to C4
Biogenic Global Warming Potential	kg CO <sub>2eq</sub>	-8.8E-03
Land use change Global Warming Potential	kg CO <sub>2eq</sub>	1.2E-06
Fossil Fuelled Global Warming Potential	kg CO <sub>2eq</sub>	1.2
Gross Global Warming Potential	kg CO <sub>2eq</sub>	1.2
Stratospheric Ozone Depletion	kg CFC <sub>11eq</sub>	2.1E-09
Photochemical Ozone Creation	kg NMOC <sub>eq</sub>	6.9E-03
Acidification Potential	mol H <sup>+</sup> <sub>eq</sub>	3.9E-03
Eutrophication Freshwater	kg P <sub>eq</sub>	7.1E-07
Eutrophication Marine	kg N <sub>eq</sub>	5.7E-04
Eutrophication Terrestrial	mol N <sub>eq</sub>	4.1E-03
Fossil Depletion	kg Sb <sub>eq</sub>	1.14
Mineral and Metal Depletion	MJ <sub>ncv</sub>	3.0E-03
Water Scarcity Depletion	m <sup>3</sup> <sub>WDP eq</sub>	1.7E-03

**Table 2 A1 to C4 Inventory Input Results/Functional Unit**

Net Fresh Water Use	m <sup>3</sup>	10.3
Secondary Material	kg	1.2E-02
Secondary Renewable Fuel	MJ <sub>ncv</sub>	0.02
Primary Renewable Material	MJ <sub>ncv</sub>	5.7
Primary Energy Renewable Not Feedstock	MJ <sub>ncv</sub>	14
Primary Energy Renewable Total	MJ <sub>ncv</sub>	19
Secondary Non-renewable Fuel	MJ <sub>ncv</sub>	0.40
Primary Energy Non-renewable Material	MJ <sub>ncv</sub>	5.7
Primary Non-renewable Energy Not Feedstock	MJ <sub>ncv</sub>	14
Primary Energy Non-renewable Total	MJ <sub>ncv</sub>	20

**Table 3 A1 to C4 Inventory Output Results/Functional Unit**

Hazardous Waste Disposed	kg	1.9E-02
Non-hazardous Waste Disposed	kg	4.6E-02
Radioactive Waste Disposed	kg	1.3E-18
Components For Reuse	kg	0
Material For Recycling	kg	2.2E-02
Material For Energy Recovery	kg	8.6E-05
Exported Energy Electrical	MJ <sub>ncv</sub>	0
Exported Energy Thermal	MJ <sub>ncv</sub>	0

### Interpretation of Results

Over half of Thermoshield's 1.5kg/m<sup>2</sup> Carbon Footprint from Greenhouse gas was from fuel use. Thermoshield paint has a total embodied energy of 23MJ/m<sup>2</sup> as a full thickness coating.

The highest energy share was the 59% coating polymers binder followed by the 12% electricity, then the 8% corrosion inhibitor and the 7% share white pigment.

Within the coating polymers, however, most fossil fuel was retained as feedstock that is recoverable if subsequently burnt for energy generation. Most oil and natural gas energy was in the organic chemicals in the paint feedstock that is also recoverable at end of life. Recoverable feedstock energy was significant in most components.

Transport consumed 10 to 30% share of energy with antioxidant and pigment having highest. Pigment production covers large land distances in long haul rail and road freight in Western Australia.

This study found evidence of environmental best practice that offer notable competitive advantage and environmental benefits. There are, for example significant input volumes of low energy:

- Raw mineral limestone powder as a white pigment reducing reliance on high energy pigments;
- High recycled content corrosion inhibitor reducing reliance on high energy smelting of virgin ores;
- High recycled content glass reducing reliance on energy intensive melting of virgin ores;
- Renewable content cellulose reducing reliance on finite fossil-fuel petrochemical thickeners plus
- Dilute antioxidant in demineralised water reducing reliance on more caustic chemicals.

Water use dominated gross resource consumption. Figure 5 shows reliance on sea water for cooling. The 37% sea water reflects reliance of oil producing nations on marine desalination plants.

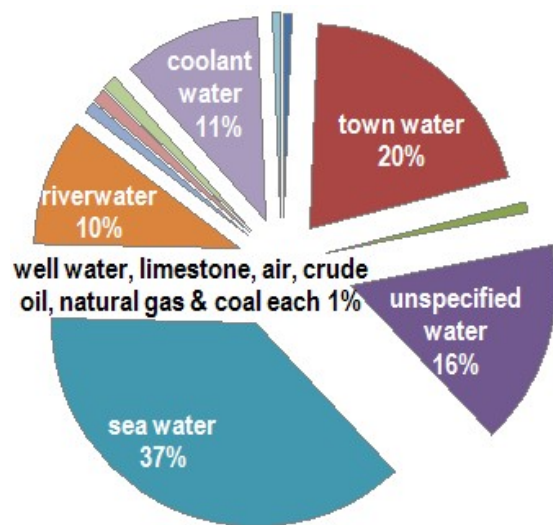


Figure 5 Water Use by Source

Public supply was the main source for process water. Unspecified includes rainwater.

Amongst solid resources, limestone and Ilmenite ores dominated. These are three sources of three white pigments used comprising calcium carbonate, titanium dioxide and zinc oxide compounds. Scrap zinc oxide and metal dross were re-used to the make corrosion inhibitor that also acts as white pigment.

## 10. Life Cycle Assessment Method

LCA Author	The Evah Institute as described at <a href="http://www.evah.com.au">www.evah.com.au</a>
Study Period	Factory data was collected from 2017 to 2022
LCA Method	Compliant with ISO 14040 and ISO 14044 Standards
LCIA method	ReCiPe Life Cycle Impact (LCIA) Assessment
Scope	Cradle to Fate including all supply chain phases and stages depicted in Figure 2.
Phases	The LCA covered all known flows in all known stages cradle to end of life fate.
Assumptions	Typical use is to Australian Facility Management professional practice.
Scenarios	Use, cleaning, maintenance plus disposal and re-use were scenario-based using Facility Management Association denoted and published typical operations.
System Boundaries	<p>The LCA system boundary depicted in Figure 1 includes all operations</p> <ul style="list-style-type: none"> <li>• A1-A3 production with upstream supply &amp; transport;</li> <li>• A4 package &amp; deliver &amp; A5 construct;</li> <li>• B1 use with cleaning, B2 maintain, B3 repair, B5 refurbish,</li> <li>• C1 demolish, C2 transport and C4 disposal.</li> </ul>
Processes	All significant resource acquisition, water, fuel & energy use, power generation & distribution, freight, refining, intermediates, manufacture, scrap re-use, packing and dispatch, installation, use, maintenance, landfill waste and emission flows from all supply chain operations to make, pack and install the product are included.



Evah industry databases cover all known domestic and global scope 1 and 2 operations.

They exclude scope 3 burdens from capital facilities, equipment churn, noise and dehydration as well as incidental activities and employee commuting.

The databases exist in top zones of commercial global modelling and calculating engines.

Electricity supply models in active databases are updated annually.

As each project is modelled and new data is available the databases are updated and audited by external Type 1 ecolabel certifiers.

Quality control methods are applied to ensure:

- Coverage of place in time with all information for each dataset noted, checked and updated;
- Consistency to Evah guidelines for all process technology, transport and energy demand;
- Completeness of modelling based on in-house reports, literature and industry reviews;
- Plausibility in 2-way checks of LCI input and output flows of data checked for validity, plus
- Mathematical correctness of all calculations in mass and energy balance cross checks.

## 11. Data Sources Representativeness and Quality

Primary data used for modelling the state of art of each operation includes all known process for:

- Technology sequences;
- Energy and water use;
- Landfill and effluent plus
- Reliance on raw and recycled material;
- High and reduced process emissions;
- Freight and distribution systems.

Primary data is sourced from clients, annual reports and their publications on corporate locations, logistics, technology use, market share, management systems, standards and commitment to improved environmental performance. Information on operations is also sourced from client:

- Supply chain mills, their technical manuals, corporate annual reports and sector experts, and
- Manufacturing specifications websites and factory site development licensed applications.

Background data is sourced from the International Energy Agency, IBISWorld, USGS Minerals, Franklin Associates, Boustead 6, Plastics Europe, CML2, Simapro 8, Ecolnvent 3 and NREL USLCI model databases. Information on operations is also sourced from:

- Library, document, NPI and web searches, review papers, building manuals and
- Global Industry Association and Government reports on Best Available Technology (BAT).

For benchmarking, comparison and integrity checks inventory data is developed to represent BAT, business as usual and worst practice options with operations covering industry sector supply and infrastructure in Australia and overseas.

Such technology, performance and license conditions were modelled and evaluated across mining, farming, forestry, freight, infrastructure and manufacturing and building industry sectors since 1995.

As most sources do not provide estimates of accuracy, a pedigree matrix of uncertainty estimates to 95% confidence levels of geometric standard deviation<sup>2</sup> ( $\sigma_g$ ) is used to define quality as in Table a<sup>1</sup>.

**Table a Data Quality Parameters and Uncertainty (U)**

Correlation	Metric $\sigma_g$	U $\pm 0.01$	U $\pm 0.05$	U $\pm 0.10$	U $\pm 0.20$	U $\pm 0.30$
Reliability	Reporting	site audit	expert verify	region	sector	academic
	Sample	>66% trend	>25% trend	>10% batch	>5% batch	<1% batch
Completion	Including	>50%	>25%	>10%	>5%	<5%
	Cut-off	0.01%w/w	0.05%w/w	0.1%w/w	0.5%w/w	1%w/w
Temporal	Data Age	<3 years	$\leq 5$ years	<10 years	<15 years	>16 years
	Duration	>3 years	<3 years	<2 years	1 year	<1 year
Geography	Focus	process	line	plant	corporate	sector
	Range	continent	nation	plant	line	process
Technology	Typology	actual	comparable	in class	convention	in sector

No data set with  $>\pm 30\%$  uncertainty is used without notation in the LCA as well as the EPD.

<sup>1</sup> Evah Institute data quality control system accords with UNEP SETAC Global LCI Database Quality 2010 Guidelines

## 12. Supply Chain Modelling Assumptions

Global building sector rules and Evah assumptions applied are defined in Table b.

**Table b Scope Boundaries Assumptions and Metadata**

Quality/Domain	National including Import and Export
Process Model	Typical industry practice with currently most common or best (BAT) technology
Resource flows	Regional data for resource mapping, fuels, energy, electricity and logistics
Temporal	Project data was collated from 2017 to 2022
Geography	Designated client, site, regional, national, Pacific Rim then European jurisdiction
Representation	Designated client, their suppliers and energy supply chains back to the cradle
Consistency	Model all operations by known given operations with closest proximity
Technology	Pacific Rim industry supply chain technology typical of 2016 to 2023
Functional Unit	Typical product usage with cleaning & disposal/m <sup>2</sup> over the set year service life
System Control	
Primary Sources	Clients and supplier mills, publications, websites, specifications & manuals
Other Sources	IEA 2023, GGT 2023, Boustead 2013, Simapro 2016, IBIS 2023, EcoInvent 2019
Data mix	Power grid and renewable shares updated to latest IEA 2023 reports
Operational	Company data for process performance, product share, waste and emissions
Logistics	Local data is used for power, fuel mix, water supply, logistics share & capacity
New Data Entry	VliegLCA, Evah Institute 2023; Global Green Tag Researchers 2023
Data Generator	Manufacturers, Evah Institute 2023; GGT 2023; Meta: IBIS 2023, Other pre-2023
Data Publisher	The Evah Institute Pty Ltd to Global GreenTag and designated client only
Person input	All contributors cited in Evah & Global GreenTag records or websites
Data Flow & Mix	
System Boundary	Earth's cradle of all resource & emission flows to end of use, fitout or build life
System flows	All known from and to air, land, water and community sources & sinks
Capital inclusions	Natural stocks, industry stockpiles, capital wear, system losses and use
Arid Practice	Dry technology adopted; Water use is factored by 0.1 as for e.g. mining
Transportation	Distance >20% than EU; >20% fuel efficient larger vehicles, load & distance
Industrial	Company or industry sector data for manufacturing and minerals involved
Mining	All raw material extraction is based on Australian or Pacific Rim technology
Imported fuel	Mix is from nearest sources is e.g. UAE, SE Asia, Canada or New Zealand
Finishes	Processing inputs with finishing burdens are factored in. If not, that is denoted
Validation	
Accuracy	10 <sup>th</sup> generation study is ± 5 to 15% uncertain due to reliability of background data
Completeness	All significant operations are tracked and documented from the cradle to fate
Precision	Tracking of >90% flows with a 90:10 rule sequentially to 99.9% and beyond
Allocation	%100 to co products on reaction stoichiometry by energetic or mass fraction
Burdens	All resource use from & emissions to community air land, water is included
Plausibility	Results are checked and benchmarked against BAT, BAU & worst practice
Sensitivity	Calculated U is reported & compared to libraries of Bath U RICE & EcoInvent
Validity Checks	Are made versus Plastics Europe, Ecobilan, GaBi & or Industry LCA literature

## References

- [1] GreenTag™ 2021 EPD Program, Product Category Rules <https://www.globalgreentag.com/EPD>.
- [2] ISO 14025:2010 Environmental labels and declarations – Type III – environmental declarations - Principles and procedures.
- [3] EN 15804:2012+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.
- [4] ISO14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines.
- [5] ISO 15686-2:2012 Buildings and constructed assets - Service life planning - Part 2: Service life prediction procedures.
- [6] ISO 15686-8:2008 Buildings and constructed assets - Service-life planning - Part 8: Reference service life and service-life estimation.
- [7] IPCC 2013, Global Warming Potential 100-year, IPCC Fifth Assessment Report Climate Change.
- [8] WMO 2014, Ozone Depletion Potentials for Steady-state, Scientific Assessment of Ozone Depletion: 2014, Global Ozone Research and Monitoring Project Report No. 55, 2014.
- [9] Van Zelm, R., Huijbregts, M., Hollander, H., Jaarsveld, H., Sauter, F., Struijs, J., Wijnen, H., Van de meent, D. 2008, European characterization factors for human health damage of PM10 and ozone in life cycle impact assessment, J O Atmospheric Environment 42(3):441-453, as applied in ReCiPe LOTOS-EUROS. DOI: 10.1016/j.atmosenv.2007.09.072
- [10] Seppälä, J., Posch, M., Johansson, M. and Hettelingh, J-P. 2006 Country-dependent Characterisation Factors for Acidification and Terrestrial Eutrophication Based on Accumulated Exceedance as an Impact Category Indicator, T Int J O LCA 11(6):403-416 Nov 2006 DOI:10.1065/lca2005.06.215
- [11] Posch, M., Seppälä, J., Hettelingh, J-P., and Johansson, M., (2008) The role of atmospheric dispersion models and ecosystem sensitivity in the determination of characterisation factors for acidifying and eutrophying emissions in LCIA, Sept 2008, I J of Life Cycle Assessment 13(6):477-486., DOI:10.1007/s11367-008-0025-9
- [12] Struijs, J., Beusen, A., van Jaarsveld, H. & Huijbregts, M.A.J. (2009b). Aquatic Eutrophication. Ch 6 in: Goedkoop, M., Heijungs, R., Huijbregts, M.A.J., De Schryver, A., Struijs, J., Van Zelm, R. (2009). ReCiPe 2008 A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. Report I: Characterisation factors, 1<sup>st</sup> Ed.
- [13] CML–IA V4.1 LCA methodology, 2002, October 2012, CML University of Leiden, Netherlands.
- [14] Guinée et al., 2002, and van Oers et al., 2002 CML LCA methodology 2002a, Institute of Environmental Sciences (CML), Faculty of Science, University of Leiden, Netherlands.
- [15] Boulay, A-M., Bare, J., Benini, L., Berger, M., Lathuilliere, M., Manzardo, A., Margni, M., Motoshita, M., Núñez, M., Pastor, A., Ridoutt, B., Oki, T., Worbe, S., Pfister, S. (2018). The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). I J of LCA. 23. 1-11. 10.1007/s11367-017-1333-8.

## Bibliography

- Australian & New Zealand (ANZECC) Guidelines For Fresh & Marine Water Quality (2000)  
<http://www.environment.gov.au/water/quality/national-water-quality-management-strategy>
- Ciroth A., Hildenbrand J., Zamagni A. & Foster C., 2015, Data Review Criteria. Annex A: LCI Dataset Review Criteria, 10.13140/RG.2.1.2383.4485 UN EP Life Cycle Initiative
- Basel Convention (2011) Control of Transboundary Movement of Hazardous Waste & Disposal  
<http://www.basel.int/portals/4/basel%20convention/docs/text/baselconventiontext-e.pdf>
- EN ISO 14024:2000, Environmental labels and declarations - Type I environmental labelling -Principles and procedures (ISO 14024:1999).
- EN ISO 14040:2006, Environmental management - Life cycle assessment - Principles and framework (ISO14040:2006).
- Franklin Associates (2023) US LCI Database <http://www.fal.com/index.html> Eastern Research Group US GreenTag™ Certification (2023) [http://www2.ecospecifier.org/services\\_offered/greentag\\_certification](http://www2.ecospecifier.org/services_offered/greentag_certification)
- IBISWorld (2014) Market Research, <http://www.ibisworld.com.au/> IBISWorld Australia
- International Energy Agency (2023) Energy Statistics <http://www.iea.org/countries/membercountries/>
- ISO 21930:2007 Sustainability in building construction - Environmental declaration of building products.
- ISO 21931-1:2010, Sustainability in building construction - Framework for methods of assessment of the environmental performance of construction works - Part 1: Buildings.
- ISO 14001:2004 Environmental management systems: Requirements with guidance for use
- ISO 14004:2004 EMS: General guidelines on principles, systems & support techniques
- ISO 14015:2001 EMS: Environmental assessment of sites & organizations (EASO)
- ISO 14020:2000 Environmental labels & declarations — General principles
- ISO 14025:2006 Environmental labelling & declarations Type III EPDs Principles & procedures
- ISO 14031:1999 EM: Environmental performance evaluation: Guidelines
- ISO 14044:2006 EM: LCA: Requirement & guideline for data review: LCI; LCIA, Interpretation results
- ISO 14064:2006 EM: Greenhouse Gases: Organisation & Project reporting, Validation & verification
- ISO 15392:2008 Sustainability in building construction General principles
- ISO 15686-1:2011 Buildings & constructed assets Service life planning Part 1: General principles
- ISO 15686-2:2012 Buildings & constructed assets Service life (SL) planning Part 2: prediction
- ISO 15686-8:2008 Buildings & constructed assets SL planning Part 8: Reference & estimation
- ISO 21929-1:2011 Sustainability in building construction Sustainability indicators Part 1: Framework
- ISO 21930:2007 Sustainability in building construction - Environmental declaration of building products.
- ISO 21931-1:2010, Sustainability in building construction - Framework for methods of assessment of the environmental performance of construction works - Part 1: Buildings.
- ISO 21932:2013 Sustainability in buildings and civil engineering works -- A review of terminology
- Plastics Europe (2023) Portal <http://www.plasticseurope.org/plastics-sustainability/eco-profiles.aspx>
- Myhre et al, 2013, Anthropogenic and Natural Radiative Forcing Chapter 8 in Stocker et al (eds.) Climate Change 2013, AR5 of the IPCC, Cambridge U Press UK. <http://www.ipcc.ch/report/ar5/wg1/>
- UNEP (2016) Persistent Organic Pollutants <http://www.chem.unep.ch/pops/> The UN
- USLCI (2023) Life-Cycle Inventory Database <https://www.lcacommons.gov/nrel/search>, USA
- U.S. Geological Survey National Minerals (2023) <http://minerals.usgs.gov/minerals/pubs/country/> USA
- US EPA (2016) Database of Sources of Environmental Releases of Dioxin like Compounds in U.S <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=20797> p 1-38, 6-9, USA

## 14. Reviewers Report Conclusions

The independent LCA reviewer's report confirmed that the LCA project report and addition information addressed the EPD.

The verifier was not involved in developing the LCA or EPD and has no conflict of interests from their organisational position.

While the report is confidential its conclusions confirmed that documentation according to set ISO Standard requirements was provided including evidence from the:

### The Evah Institute, the LCA developer:

- a) Recipes of input and output data of unit processes used for LCA calculations ✓
- b) Datasheets of measures, calculations, estimates and emails with sources as in Table 5 ✓
- e) References to literature and databases from which data was extracted as noted in Table 5 ✓
- g) Notes on supply chain processes and scenarios satisfying requirements of this Standard ✓
- i) Embodied Energy shares as used for sensitivity analyses re ISO 14044:2006, 4.5.3.3 ✓
- j) Proof percentages or figures in calculations in the end-of-life scenario ✓
- k) Notes on proof of % and allocation calculations ✓
- o) All operations covered Vs criteria and substantiation used to determine system boundaries ✓

### Product Manufacturer in:

- c) Specifications used to create the manufacturer's product ✓
- d) Citations, references, specifications or regulations & data showing completeness ✓
- f) Specification demonstrating that the building product can fulfil the intended use ✓

### The Certifier Global GreenTag on:

- l) Notes and calculation of averages of different locations yielding generic data ✓
- m) Substantiating additional environmental information ISO 14025:2006, 7.2.4 ✓
- n) Procedures for data collection, questionnaires, instructions, confidentiality deeds ✓

### Requiring No Evidence:

As the EPD is cradle to fate as well as PCR compliant the independent reviewer did not need to:

- h) Substantiate a few stages as all stages were substantiated ✓
- p) Substantiate alternatives when no other choices and assumptions were applied ✓
- q) Demonstrate consistency for few stages as the same rules in Tables a and b applied to all. ✓