Global GreenTag
International EPD Program

EPD™

Environmental Product Declaration

Bird Habitats Pty Ltd

Thermal Haven Nest Boxes

Drouin Victoria 3818 Australia

BIRD HABITATS
one tree at a time

Mandatory Disclosures

EPD type	Cradle to grave	**EPD Number**	BH 01 2023EP
Issue Date	19 Nov 2023	Valid Until	19 Nov 2026
Demonstration of Verification			
Product Category Rules (PCR)	Global GreenTag International Platform EPD compliant with the ISO14025 standard [1] impact assessment methodology in reference EN15804 [2] and PCR WNB: 2023. [3]		
☑ **Internal**	16Nov 2023 — LCA Developed by Delwyn Jones, The Evah Institute 19/11/2023 — EPD Reviewed by David Baggs, Global GreenTag Pty Ltd		
☑ **External**	16 Nov 2023 — Third Party Verifier[a] Murray Jones Ecquate Pty Ltd		
Communication	This EPD discloses potential environmental outcomes compliant with ISO14025:2010 and independent external verification of this declaration and data[a] ensures it is fit for business-to-consumer communication. [1]		
Comparability	Different program EPDs may not be comparable. Comparability is further dependent on the product category rules and data source used.		
Reliability	LCIA results are relative expressions that do not predict impacts on category endpoints, exceeding of thresholds, safety margins or risks.		
Objectives	To show improved, net-zero, net-positive and regenerative results and timely imperatives to secure viable climate and biodiversity on earth against a background of increasing disasters attributable to anthropogenic climate change.		
Explanations	Further explanatory information is available at info@globalgreentag.com or by contacting certification1@globalgreentag.com.		

EPD Program Operator	**LCA and EPD Producer**	**Declaration Owner**
Global GreenTag International Pty Ltd	Ecquate Pty Ltd	Bird Habitats Pt Ltd
L38, 71 Eagle St., Brisbane	PO Box 123 Thirroul	Drouin, Victoria
QLD 4000 Australia	NSW 2515 Australia	VIC 3818 Australia
Phone: +61 (0)7 33 999 686	Phone: +61 (0)7 5545 0998	Phone: +61 (0)438 555 570
http://www.globalgreentag.com	http://www.evah.com.au	https://birdhabitats.com.au

Program Description

EPD Scope	The scope is cradle to grave A1 to C4 + D as defined by ISO14025. [1]
System boundary	The system boundary with nature includes material and energy acquisition, processing, manufacture, transport, installation, use plus waste arising to end of life.
Stages included	All known operations and stages in modules A1 to D3 are included.
Information	Figure 1 depicts A1 to C4 modules inside this cradle to grave system boundary.

Model	Building Life Cycle Assessment																	Beyond system		
Information	Actual				Scenarios															
Stages	Product			Construct		Use							End-of-Life					Benefit & load		
						Fabric					Operate									
Modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D1	D2	D3
Operations Cradle to Grave Fate C_2F & beyond system to Cradle (C_2C)	Resources	Transport	Manufacture	Transport	Construct	Use	Maintain	Repair	Replace	Refurbish	Energy use	Water use	Demolish	Transport	Process Waste	Disposal		Reuse	Recovery	Recycling
C_2F	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		O	O	O
C_2Gate+Options	M	M	M	O	O	O	O	O	O	O	O	O	O	O	O	O		O	O	O

Figure 1 Modules A to C Within the Cradle to Grave System Boundary and D Beyond

Data Sources

Primary Data	Data is from primary sources 2018 to 2023 including manufacturer and supplier standards, logistics, technology, market share and management system in accordance with EN ISO 14044:2006, 4.3.2. All are physically allocated not economically allocated.
A1-A3 Stage inclusions	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 fate of all flows at end of life.
Variability	Significant differences of average LCIA results are declared.
Chemicals of Concern	Contains no substances in the European Chemicals Agency “Authorised or Candidate Lists of Substances of Very High Concern (SVHCs)”.

LCA Data Quality

Data quality parameters are tabled below. Data was <10 years, cut-off & quality complies with ISO14025. [1]

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

System Analysis Scope and Boundaries

Figure 2. shows included processes in a cradle to grave system boundary to end of life fates reuse, recycling, or landfill grave. Stages A1 to 3 model actual operations to acquire, refine, transport, fabricate, coat, use, clean, repair, reuse and dispose of metal, masonry, ceramic, timber, glass, plastic and composites. Stage A4 to C4 are modelled on typical scenarios to forecast operations including those of:

- Mining, extracting and refining resources to make commodities and packaging;
- Acquiring, cultivating, harvesting, extracting, refining produce and biomass;
- Fuel production to supply power and process energy and freight;
- Chemicals use in processing resources, intermediates and ancillaries;
- Process energy, fuel and freight of resources, intermediates and ancillaries;
- Use, cleaning, recoating, repair, recycling, re-use and landfill, as well as
- Infrastructure process energy transformed and material wear loss e.g. tyres.

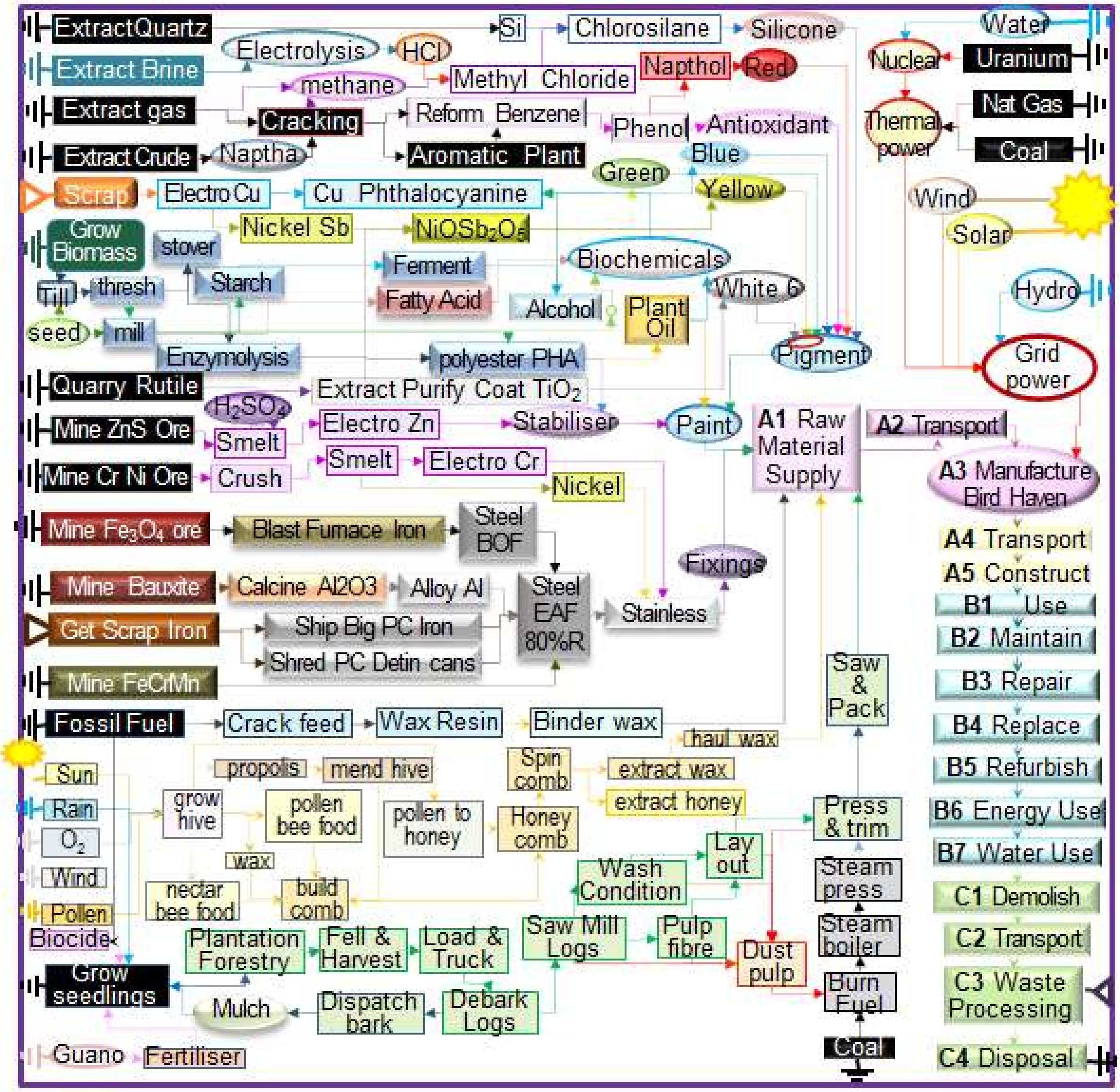

Figure 2. Product Process Flow Chart

Details of Manufacturer

The declared product Thermal Haven Nest Boxes are designed to restore habitats for hollow-dependent fauna. Bird Habitats manufacture them to restore habitats for hollow-dependent fauna for future generations.

The design addresses temperature variations within the inner nesting space. Air is used as a thermal buffer to create a stable microclimate and limit extreme temperature variations. Corner profiles create a cavity between external wall, roof, floor panels and the internal nesting space. Ventilated cavities promote air convection to avoid interior overheating and allow for any water ingress to drain. No formaldehyde, glue or plastics are used.

Quality, sustainably sourced materials are used to produce durable nest boxes. The products are designed and made in Drouin Victoria from Australian PEFC-certified hardwood timber 89% home scrap, stainless steel fixings and beeswax. Each nest box is fitted with a stainless steel QR code for easy monitoring.

Product Information

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

Brand Name & Code	Bird Habitats
Range Names	Thermal Haven Nest Boxes
Factory warranty	Fit for purpose use
Manufacturer	Thermal Haven Nest Boxes
Factory address	Drouin, Victoria 3818, Australia
Site representation	Made in Australia. Uses are assumed as for Australasia and Pacific Rim
Time	Made in and sold from 2022 for single use
Application	Wildlife nest boxes to incubate, raise and house young until independent
Function	Nesting boxes for wildlife to mate, nest and raise young safely in comfort
Lifetime [5,6]	20 years Reference Service Life (RSL) modelled
Declared unit	8.8kg Thermal Haven Nest Boxes
Functional unit	Thermal Haven Nest Boxes /kg use 20 years cradle to grave

Whole of life Performance

Health Protection	The product does not contain levels of carcinogenic, toxic or hazardous substances that warrant ecological or human health concern cradle to grave. It passed the Ecospecifier Cautionary Assessment Process (ESCAP) and no issues or red-light concerns existed for product human or ecological toxicity.
Effluent	LCI results and ESCAP raised no red light concerns in emissions to water.[1]
Waste	Cradle to grave waste to landfill from operations was non-hazardous.
Environmental Protection	Continuous improvement under the maker's uncertified management system avoids toxics, waste and pollution plus reduce their material and energy use.
Environmental Health Effects	No potential in-use impacts on environment or health are known.

1 According with national standards in ANZECC Guideline For Fresh & Marine Water Quality (2000)

Product Components

This section summarises factory components, functions, source nation and % mass share. Product content listed below has a ±5% range and confidence interval 90% certain to contain true population means at any time.

Listing such certainty considers normal resource acquisition, supply chain, sedimentation, seasonal, manufacturing and product variation over this EPD's validity period.

This also allows for intellectual property protection whilst ensuring fullest possible transparency.

Base Material Origin and Detail

Table 2 lists key components by function, type, sources and % mass share. Boxes were not packaged.

Function	Component	Source	Amount
Internal walls	Weathertex natural	Newcastle New South Wales	>50 <51
Exterior walls	Weathertex primed	Newcastle New South Wales	>38 <39
Hardwood Corners	Victorian Ash[2]	PEFC[3] Victoria	>9.1 <9.2
Screws & tag	316 Stainless Steel	Germany	>1.0 <1.1
Hardwood Guard	Jarrah[4]	PEFC South Western Australia	>0.7 <0.8
Coating	Beeswax	Australia	<0.06

This excludes the tree-fixing kit, covered and open landing perch, entrance tunnel, ladder and anti-Myna baffle.

Product Functional & Technical Performance Information

This section provides manufacturer specifications and additional information.

Material quality	>95% PEFC and Global GreenTag International certified sustainable lumber.
Design	Designed to restore habitats for hollow-dependent fauna. Designed to create a cavity between external walls and internal nesting space. Entry hole size, shape and location can be adapted to suit targeted species.
Thermal performance	Ventilated air gaps create a thermal buffer for the occupants. Internally stable microclimate limits extreme temperature variations. Thermal profile results comparable to tree hollows are at https://www.thermalhaven.com.au/research.
Moisture drainage	Cavity vents allow moisture ingress to drain.
Wildlife safety	Low VOC, no plastics, glues or formaldehydes
Health Safety & Environment	Apart from compliance to occupational and workplace health safety and environmental laws no additional personal protection is considered essential for manufacture, use or reuse.
Standard Reference	Test results are available at https://www.thermalhaven.com.au/research.
Practices Reference	https://www.info@birdhabitats.com.au
Effluent	LCI results and ESCAP raised no red-light concerns in emissions to water.[5]
Disposal	No production waste is sent to river, land or ocean outfalls or council landfills.

[2] Eucalyptus Marginata
[3] Programme for the Endorsement of Forest Certification
[4] Eucalyptus delegatensis and Eucalyptus regnans
5 According with national standards in ANZECC Guideline For Fresh & Marine Water Quality (2000)

Scenarios Descriptions

This section defines modelling stages scenarios A4 to D3 beyond actual operations in module A1 to A3.

Module	Type specified	Amount	Type specified	Amount
Construct				
A4 Transport factory to depot then to site	Steel Sea Shipping	13,000	85% Capacity	Full back load
	Wood Interstate Rail	1300 km	85% Capacity	Full back load
	Box 25t semi-trailer	200 km	85% Capacity	No back load
	Box 2 to 5t vans	20 km	85% Capacity	No back load
A5 Install	Renewable Power	100%	Rain water	100%
	VOCs indoors	0%	Packaging & Waste	0%
Building Modules				
B1 Use	VOCs	0%	No other flows in box	0%
B2 Maintain	Nest fit for purpose	0%	Nesting wildlife	100%
B3 Repair	Nest fit for purpose	0%	No other flows	0%
B4 Replace	Nest fit for purpose	0%	No other flows	0%
B5 Refurbish	Nest fit for purpose	0%	Nesting wildlife	100%
B6 Energy use	Wildlife nest off grid	0%	Solar and wind energy	100%
B7 Water use	Wildlife nest off grid	0%	Rain, dew and forage	100%
End of Life Modules				
C1 Demolish	Fit for purpose nest	0%	No other flows for box	0%
C2 Transport	Fit for purpose nest	0%	No other flows for box	0%
C4 Disposal	Fit for purpose nest	0%	No other flows for box	0%
Beyond System Boundary Modules				
D1 Reuse	Fit for purpose nest	100%	No other flows for box	0%
D2 Recover	Fit for purpose nest	0%	No other flows for box	0%
D3 Recycle	Fit for purpose nest	0%	No other flows for box	0%

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.

Global warming forcing Climate Change	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 "***climate emergency***".
Ozone layer depletion	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 *"**ozone hole**"* reliance on ozone-safe refrigerants, aerosols and solvents is essential to avoid further its depletion and enable accumulation of naturally-formed ozone.
Acidification	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 "***acid rain***" 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.
Eutrophication of terrestrial, freshwater and marine life	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 "***algal blooms***" is nitrogen (N, NOx, NH_4) and phosphorus (P, PO_4^{3-}) in rain run-off over-fertilised land catchments.
Photochemical ozone creation	Tropospheric photochemical ozone, called "***summer smog***" 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.
Depletion of minerals, metals & water	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 "***extinction rebellion***" calls on adults to secure climate, reserves and biodiversity for current and future generations.
Depletion of fossil fuel reserves	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 "***peak oil***" 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.

Module A1 to C4 Cradle to Cradle Inventory and Damage Impact Results

Table 1 shows impact and inventory results, units with descriptions and references to methods.

Table 1 A1-3 to C4 Impact & Inventory Results/Functional Unit

Result	Units	A1-D3	Description of Methods
Climate Change biogenic	kg CO_{2eq}	-2.5	GWP sequestered from air [4]
Climate Change luluc	kg CO_{2eq}	1.3E-04	GWP land use & change [4]
Climate Change fossil	kg CO_{2eq}	2.4	GWP fossil fuels [4]
Climate Change total	kg CO_{2eq}	-5.2E-02	Global Warming Potential [4]
Stratospheric Ozone Depletion	kg CFC_{11e}	3.0E-09	Stratospheric Ozone Loss [5]
Photochemical Ozone Creation	kg $NVOC_e$	1.1E-02	Summer Smog [6]
Acidification Potential	mol H^+_{eq}	3.1E-03	Accumulated Exceedance [7]
Eutrophication Freshwater	kg P_{eq}	2.8E-06	Excess freshwater nutrients [8]
Eutrophication Marine	kg N_{eq}	5.5E-04	Excess marine nutrients [9]
Eutrophication Terrestrial	mol N_{eq}	1.7E-02	Excess nutrients to land [8]
Fossil Depletion	kg Sb_{eq}	1.8	Abiotic Depletion minerals [9]
Mineral and Metal Depletion	MJ_{ncv}	1.9E-04	Abiotic Depletion fossil fuel [10]
Water Scarcity Depletion	$m^3_{WDP\ eq}$	3.9E-03	Water Deprivation Scarcity [11,12]
Net Fresh Water Use	m^3	2.4E-02	Lake, river, well & town water
Secondary Material	kg	1.2	Post-consumer recycled (PCR)
Secondary Renewable Energy Use	MJ_{ncv}	2.9	PCR biomass burnt
Primary Renewable Feedstock Material	MJ_{ncv}	23	Biomass retained material
Primary Renewable Energy Used	MJ_{ncv}	1.5	Biomass fuels burnt
Total Primary Renewable Energy	MJ_{ncv}	25	Biomass burnt + retained
Secondary Fossil Energy Use	MJ_{ncv}	0.02	PCR fossil-fuels burnt
Primary Fossil Feedstock Material	MJ_{ncv}	2.9	Fossil feedstock retained
Primary Fossil Energy Use	MJ_{ncv}	26	fossil-fuel used or burnt
Total Primary Fossil Energy Use	MJ_{ncv}	29	Fossil feedstock & fuel use
Hazardous Waste Disposed	kg	3.1E-03	Reprocessed to contain risks
Non-hazardous Waste Disposed	kg	7.5E-02	Municipal landfill facility waste
Radioactive Waste Disposed	kg	1.4E-18	Most ex nuclear power stations
Components For Reuse	kg	0.18	Product scrap for reuse as is
Material For Recycling	kg	0.03	Factory scrap to remanufacture
Material For Energy Recovery	kg	1.2E-05	Factory scrap use as fuel
Exported Energy Electrical	MJ_{ncv}	0	Uncommon for building products
Exported Energy Thermal	MJ_{ncv}	0	Uncommon for building products

Life Cycle Assessment Method

LCA Author	The Evah Institute is described at www.evah.com.au.
Study Period	Factory data was collected from 2022 to 2023.
LCA Method	Compliant with ISO 14040 and ISO 14044 Standards
LCIA method	ReCiPe 2016 Life Cycle Impact Assessment (LCIA)
Scope	Cradle to fate including all supply chain phases and stages depicted in Figure a
Phases	The LCA covered all known flows in all known stages cradle to end of life fate.
Assumptions	Use is to typical Australian wildlife conservation professional practice.
Scenarios	Use, cleaning, maintenance plus disposal and re-use were scenario-based using Facility Management Association denoted and published typical operations.
Processes	All known processes are included from resource acquisition, water, fuel & energy use, power generation & distribution, freight, refining, intermediates, manufacture, scrap re-use, packing and dispatch, installation, use, maintenance and landfill. All significant waste and emission flows from all supply chain operations used to make, pack and install the product are included.
System Boundary	Figure 3 depicts A1 to C4 operations inside this cradle to grave system boundary.

Model	**Actual**					**Scenarios**												**Beyond system to Cradle**		
Information	**Building Life Cycle Assessment**																			
Stages	Product			Construct		Use Fabric					Use Operate		End-of-Life					Benefit & load		
Modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D1	D2	D3
Operations Cradle to Grave Fate C_2F & beyond system to Cradle (C_2C)	Resources	Transport	Manufacture	Transport	Construct	Use	Maintain	Repair	Replace	Refurbish	Energy use	Water use	Demolish	Transport	Process Waste	Disposal		Reuse	Recovery	Recycling
C_2F	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		O	O	O
C_2Gate+Options	M	M	M	O	O	O	O	O	O	O	O	O	O	O	O	O		O	O	O

Figure 3 Life Cycle Assessment Operations Scope Cradle to Grave

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. Electricity supply models in active databases are updated annually. As each project is modelled and new data is available the databases are updated. They are then audited by external Type 1 ecolabel certifiers. The databases exist in top zones of commercial global modelling and calculating engines. Quality control methods are applied to ensure:

- Coverage of place in time with all information for each dataset noted, checked and updated;[6]
- Consistency to Evah guidelines for all process technology, transport and energy demand; [7]
- Completeness of modeling 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.

[6] Jones D G (2004) LCI Database for Commercial Building Report 2001-006-B-15 Icon.net, Australia
[7] Evah Tools, Databases and Methodology Queensland, Australia at http://www.evah.com.au/tools.html

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 client annual reports and 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 license applications.

Background data is sourced from the International Energy Agency, IBISWorld, USGS Minerals, Franklin Associates, Boustead 6, Plastics Europe, CML2, Simapro 9.5, EcoInvent 3.9 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^2 (σ_g) is used to define quality as in Table a.[8]

No data set with >±30% uncertainty is used.

Table a Data Quality Uncertainty (U)

Correlation	Metric σ_g	U ±0.01	U ±0.05	U ±0.10	U ±0.20	U ±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	≤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

[8] Evah Institute data quality control system accords with UNEP SETAC Global LCI Database Quality 2010 Guidelines

Supply Chain Modelling Assumptions

Australian 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	It is typical industry practice with currently most common or best (BAT) technology.
Resource flows	LCI uses regional data for resource mapping, fuels, energy, electricity and logistics.
Temporal	Project data collated over the previous 4 years represents averages over the last year.
Geography	Jurisdiction is of the declared client, site, regional, national, Pacific Rim then Europe.
Representation	It represents the declared client, their suppliers and energy providers to each cradle.
Consistency	All known operations are modelled according to operations with closest proximity.
Technology	The industry supply chain modelled is typical recent Pacific Rim technology and practice.
Functional Unit	A 20 or 60 year period of typical service life, use, cleaning and disposal/kg or m^2 applies.
System Control	
Primary Sources	Client and supplier mills, publications, websites, specifications and manuals are used.
Other Sources	Recent IEA, GGT, Simapro, IBIS, EcoInvent sources used and cited in the LCA reports.
Data mix	Power grid and renewable shares are updated according to the latest IEA reports.
Operational	Company data is used 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	New data is entered by current researchers at Malaika LCT, Evah and GGTI.
Data Generator	All via current manufacturers, Evah, GGTI, IBIS and others is cited and in LCA reports.
Data Publisher	Publishers include the Evah Institute, GGTI and designated clients only.
Contributors	All professional and personal contributors are cited in Evah & GGTI records.
Data Flow & Mix	
System Boundary	All known resources and emissions are modelled from Earth cradles to end of life fate.
System flows	All known flows are modelled from and to air, land, water and community sources &
Capital inclusions	Natural stocksΔ, industry stockpilesΔ, capital wear Δ, 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	The fuel mix is from nearest sources such as UAE, SE Asia, Canada or New Zealand.
Finishes	Processing inputs with finishing burdens are factored in otherwise that is denoted.
Validation	
Accuracy	10th generation study is ± 5 to 15% uncertain due to some background data.
Completeness	All significant operations are tracked and documented from the cradle to grave.
Precision	Tracking of >90% flows applies a 90:10 rule sequentially to 99.9% and beyond.
Allocation	All is allocated to co products on reaction stoichiometry by energetic or mass fraction.
Burdens	All known resource use from & emissions to community air land, water are included.
Plausibility	Results are checked and benchmarked against BAT, BAU & worst practice.
Sensitivity	Calculated U is reported & compared to Bath U RICE & EcoInvent libraries.
Validity Checks	Checks are versus Plastics Europe, Bath U RICE & or Industry LCA Literature.

LCIA Methodology References

[1] ISO 14025:2010 Environmental labels and declarations – Type III – environmental declarations - Principles and procedures

[2] EN 15804:2012+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

[3] GreenTag™ 2023 EPD Program, Product Category Rules https://www.globalgreentag.com/epd-program.html

[4] Intergovernmental Panel on Climate Change (IPCC) 2013, Assessment Report 5 Climate Change, Ch 8 Anthropogenic and Natural Radiative Forcing, Global Warming Potential 100-year, http://www.ipcc.ch

[5] WMO 2014, Ozone Depletion Potentials for Steady-state, Scientific Assessment of Ozone Depletion: 2014, Global Ozone Research and Monitoring Project Report No. 55, 2014

[6] 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

[7] 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

[8] 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 LCA 13(6):477-486., DOI:10.1007/s11367-008-0025-9

[9] 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, 1st Ed

[10] CML–IA V4.1 LCA methodology, 2002, October 2012, CML University of Leiden, Netherlands.

[11] 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

[12] 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

[13] 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

[14] Di Sacco, A., et al., Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery & livelihood benefits. Global Change Biology, 2021. 277: p.1328-1348. DOI 10.1111/gcb.15498

[15] IPCC, Assessment Report 6 Climate Change 2021: The Physical Science Basis. https://www.ipcc.ch/

EPD:BA™

Environmental Product Declaration:Benefit Addendum

Nature Positive+ EPD :BA Declaration
Compliance beyond EN 15804+A2, ISO 14025 ISO 21930

Global GreenTag International

Other Information

The United Nations (UN) Nature Positive (N+) Program provides global impetus for EPDs to consider gain versus loss in climate and biodiversity security [27, 28, 29]. But the reach of most LCIA methods such as the leading ReCiPe is modelling damage and depletion from maxima to zero as depicted on the left-hand side of in Figure 7 [29, 30, 31, 32]. Conventional LCIA models environmental damages to e.g. climate and loss of human health, ecosystem quality and resource supply [32, 33}.

The reach of N+, however extends scientific sightlines beyond zero damage to quantify benefits, gains and regeneration [33, 34], 35. Other information in N+ EPDs sight beyond damage to define additional information on net-positive benefit outcomes including many gains depicted on the right-hand side of Figure a [30 to 32].

Figure 4 depicts the ReCiPe LCIA method modelling damage, depletion and loss versus the Evah Life Cycle Benefit indicators (LCBA) method modelling benefit, repletion and gain to assess net-loss and net-gain of climate security, human wellness and resource supply viability [33 to 36].

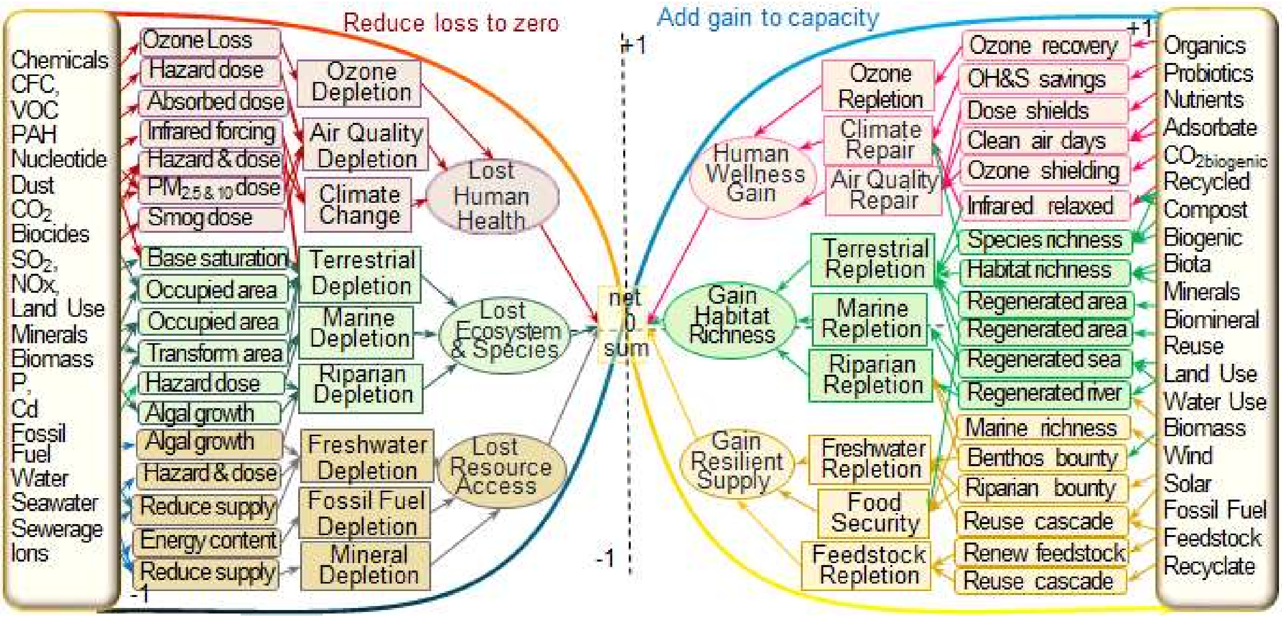

Figure 4 ReCiPe LCIA of damaging loss versus Evah LCBA of beneficial gain

Such extended assessment is applicable to empower communication and reduce barriers for regenerative and nature-positive initiatives. LCA of benefits offers community, government and business a new environmental science tool with examples of methods to measure gains in accelerating restoration and climate security.

Using LCBA in conjunction with conventional LCIA modelling of damages allows LCA modelling of damages to and beyond of zero climate, health, ecosystems and supply losses to beneficial gains in e.g. climate, wellness, biodiversity and supply security.

Reaching to quantify and show positive gains well beyond the negative and zero loss outcomes, LCBA enables a truer market assessments. The capacity to report positive metrics can also reduce prevalent greenwashing and reliance on bad news that has disempowered scientifically valid communications and efforts to engage community action.

Environmental Benefit Terminology

Key environmental benefits contributing to ecological regeneration of climate and biodiversity security are tabled below with common names and responses for each indicator.

Climate Security	Reliance on renewable energy is vital to restore thermal energy differentials, from equator to poles. Differential forcing of ocean current and wind circulation blends and regulate climate to reduce extreme weather events. Forest, wilderness and algal growth can drawdown such gasses. Carbon banked in standing forests, detritus, roots and soils brakes climate change. Greenhouse gas *d*rawdown and sequestration in product biomass is vital for "***Climate security***".
Water Security	***"Water security*** arises from conservation and recycling as well as reliance on renewable and reclaimed biomass to avoid climate-change-induced drought. Hectares of intensive forest and plantings stabilise rain catchment and ground water table levels. Ground mulches retain soil hydration and reduce water stress.
Ozone Repletion	Repairing the planet's stratospheric ozone solar shield protects plants, humans and animals allowing them to be ***sun-safe****"* for longer in the outdoors. Ground level oxygenation via growing plants and algae is a chief way to enable accumulation higher level naturally-formed Ozone***.*** Restoring the ozone layer also depends on use of ozone-safe refrigerants, aerosols and solvents
Buffered air, land and waters	Acid rain-free air-sheds are safer for natural terrestrial, aquatic and urban communities. Buffered air-pH supports healthy soil and waterways, nitrogen fixation vital for plant growth and natural decomposition. Safe pH supports health of fisheries, forests, buildings and materials. Chief ways to enhance "***natural-rain****"* are reliance on renewable fuels and power supply.
Oxygenated terrestrial and aquatic life	Nutrient and oxygen availability balances in natural waters promotes healthy plant growth, water and habitat security for aquatic and terrestrial organisms across related ecosystems. Chief ways to enhance healthy waterways is to tightly control slow-release fertilisers avoiding synthetic nutrients in rain run-off land catchments.
Sweet-air	Smog-free air in summer near ground level when most people live and breathe outside is generated by plants and avoiding or filtering pollutants. **Sweet-air** enables healthy vegetation, crops and humans to thrive. Chief ways to enhance sweet-air are reliance on low-emission renewable energy and non-volatile chemicals.
Resource Repletion	The extinction rebellion youth movement calls on governance to secure climate, material reserves and biodiversity for current and future generations. Chief ways to ensure resource repletion include investing in sustainably managed **"circularity",** recycling, renewables and reclaimed biomass. This retains accessible, plentiful, essential valuable raw material, medicinal, chemical, feedstock and fuel stock.
Biodiversity Security	Extensive bushland, biodynamic and organic agriculture plus standing forests offer natural land use ranges and corridors for wildlife, herds and flora **"biodiversity**": • habitat bird, bee, pollinator, avian, worm biome, shelter, forage and grazing • leaf & litter forage enhance soil condition, mulch, nutrition and retention, • soil microbiota, detritus-feeders and biotic refuges reduce temperature stress • CO_{2e} sequestered in natural habitat, biomass & soil braking climate change.
Ecological Wellness	Human ecological health benefits flow from reliance on renewable and reclaimed biomass instead of fossil fuel. Chief ways to enhance **"wellness"** include avoiding particulates and pollution, smog, volatile organics and carcinogens. Climate and ozone security and safer air-sheds ensue for natural terrestrial, aquatic and urban communities.

Life Cycle Benefit Assessment Reference Framework

This section summarises the LCBA framework of measures metrics and indicators. Local and global human wellness, habitat regeneration and supply resilience and circularity outcomes are framed against United Nations Sustainable development goals (UN SDG)s [16 to 32]. LCBA reaches beyond zero loss to show gains in climate, wellness, biodiversity and supply security.

LCA framework of LCBA indicators

Benefit Layer	Exposure & Jurisdiction	Unit/annum	Local	Global	UN	Circularity
Healthy Able Life	Years (HALY)	HALY/capita		benchmark	SDG	% Capacity
Local Shelter	Household shelter	m^2 GFA	m^2 GFA	UN eq	1	Housing
Fresh Food	Affordably nourished	kJ	kJ UN eq	UN eq	2	Nutrition
Fresh Air	Oxygen indoors	kg O_2	kg O_2	O_2 C1750	3	Oxygenation
Clean Air	$PM_{2.5}$ dust-free	µg PM2.5	µg PM2.5	PM C1750	3	Decongestion
Sweet Air	VOC free indoors	IAQ	µg VOC	VOC C1750	3	Inhalation
Sun Safety	Ozone layer repair	kg O_2 outdoors	O_3 stratosphere	O_3 C1750	3	Ozonating
Time in Nature	100 days recreation pppa	R&R Ha	R&R Ha	Ha C1750	3	Free-time
Medical Access	Paramedic Care	hours	hours to aid	hours to aid	4	Medic-access
Work Dignity	>30hrs paid work/week	hours	$eq/hour	km UN eq	5	Secure-work
Fresh Water	Potable rain hydrated	m^3	l rain	rain C1750	6	Potability
Supply Energy &	Resource Viability (SERV)	SERV/capita		metric		% Capacity
Viable Water	Refill local reservoirs	m^3 freshwater	l/km	Rain C1750	6	Freshwater
Viable Air	Photosynthetic Cities	kg O_{2e100}	O_2 urban	O_2 C1750	7	Oxygenation
Viable C-bank	Resink Carbon in product	kg CO_{2e100}	kg	CO_{2e100}	7	Bank-carbon
Viable Energy	Reliance on renewable	kg renewed	MJ/gross	oil eq	7	Renewability
Viable Food	Reliance on local food	kJ km	kJ kl	UN eq	8	Food autonomy
Viable Supply	Refuel local reserves	kg feedstock	km/gross	oil eq	9	Autonomy
Viable Mineral	Recycle scarce material	MJ elemental	MJ km access	oil eq	10	Mineral security
Viable Feedstock	Recycle material & scrap	MJ recycle	MJ gross	oil eq	10	Recyclability
Viable Disaster	Reserved sustenance	t back-up	t UN eq	UN eq	11	Recoverability
Viable Shelter	Refuges in disasters	bed pc	m^2 GFA	GFA	11	Safe havens
Positive Ecosystem	ReFormation (PERF)	PERF/Ha		C_{1750} mark		% Capacity
Natural Access	Nature parks & tracks	m^2 R&R	Access	Local reach	12	Natural Access
Urban Bounty	Pre-urban carrying capacity	t flora/GFA	Species	capacity	12	Greenspace
Soil Carbon	Carbon banking	kg CO_{2e20}	kg CO_{2e20}	kg CO_{2e20} C1	13	Soil-Carbon
Climate Brakes	Carbon drawdown	t CO_{2e20}	Soil CO_{2e}	Worms	13	Climate safety
Plants & Algae	Carbon drawdown	t CO_{2e100}	Biomass	Algae	13	Climate security
Aquatic Stock	Species rich range	t frog stock	Species	Frogs	14	Aquatic bounty
Marine Stock	Species richness & range	t fish stock	Species	Whales	14	Marine bounty
Wildlife Habitat	Corridor & refuge range	biomes	Species	Apex species	14	Linked Ranges
Terrestrial Stock	Rich flora & fauna range	t Terrastock	Species	Bears	15	Wildlife rich
Avian Stock	Species rich refugia	t Avistock	Richness	Birds	16	Abundance
Pollinator stock	Species richness & range	t Beestock	Species	Bees	16	Biodiversity
Nature Reserve	Scarce reserves restocked	t Reserve	Resources	Capacity	17	Reserves

Backgound on the Life Cycle Benefit Assessment Period

Some materials and practices inherently promote wellness and like medicine others inherently destroy illness. Thermal Haven supply chain and nesting reports confirm a range of inherently positive outcomes /kg. The functional unit is a kilogram of the nest box used over 20 years cradle to grave.

Positive and net-positive gains and benefits can offset damages and loss. Benefits from less and avoided impacts and gains arising from properties inherent within a component or utility can also be additive. For example biomass generating more clean oxygen while drawing down carbon dioxide from air enacts braking on greenhouse gas forcing of anthropogenic climate change. Together they increase wellness.

In the data period from 2017 to 2023 that this EPD covers, however, many worst-ever-recorded and widespread natural and social disasters also disrupted supply chains locally nationally and globally. After widespread worst ever recorded natural and social disasters from 2017 to 2023, few benefits were expected for the geographical area near Newcastle in New South Wales (NSW) where most Thermal Haven lumber was sourced. They also devastated Much of Victoria where the other timber was sourced.

A report from the NSW Department of Primary Industries described historic social and natural disasters impacts on natural land, bush, urban, air and aquatic and marine environments 2017 to 2020 [32].

After the most severe drought in 250 years, in November 2019 the NSW state's worst bushfire season in 250 years began when more land was burnt than all 25 years previously. 'Black Summer' bushfires caused extensive and severe emergencies.

By late summer and autumn widespread rains caused extensive flooding in NSW coastal drainages with many towns having their highest daily rainfall on record. For the rest of 2020 much of NSW received well above average rainfall [32]. Such fire, rain and flood runoff meant record pollution impacts of most freshwater, estuarine and coastal waterways [32 and 33].

In 2020 with COVID-19, international and state borders were closed which severely restricted people's movement within Australia [34 and 35]. By mid-2020 local recreational activity increased mainly because when people could not travel to work or far from home went out to exercise locally where permitted.

Despite compelling positive results shown in the following section this EPD also illustrates that nature positive outcomes are imperatives for regeneration to combat devastating natural disasters in recent years attributable to anthropogenic climate change [15].

After widespread worst-ever recorded natural and social disasters from 2017 to 2023 locally, nationally and globally disrupted security no benefits were expected from:

- urban stock of flora in parks, walls and greenspace for urban life.
- aquatic stock of frogs in rivers, lakes and dams, aquatic life and
- marine and fish stock in nearby estuaries, bays and oceans for marine life.

Through 2019/20, with near normal recreational fishing activity rates NSW finfish and invertebrate catch compositions and key species relative importance were stable [31]. Catch levels for many species varied with lower catches for most species. Compared to 2017/18 some common species catches were

- worst minus 50% Golden Perch, 52% Murray Cod, 54% Grey Morwong, 66% Australian Bass and 68% Rainbow Trout.
- lower loosing 35% Dusky Flathead, 43% Sand Flathead and 43% Mulloway.
- higher with additional 5% Snapper 13% Sand Whiting, 14% Bream and 27% Silver Trevally.

Positive benefit, gain and circularity results for a particular outcome type at levels ranging from

- improvement ≤100% damage not offsetting loss.
- net-zero 100% gain or loss offsetting damage.
- net-gain ≥100% benefit exceeding damage and loss.
- regenerative ≥200% benefit and gain beyond and loss

The results in the next sections illustrate if, how and why nature positive wellness, ecosystem and supply benefits arise from reliance on renewable energy and resource circularity.

Cradle to Cradle Results: Improved Negative Outcomes

Table a lists improved but still net-negative damage and loss including for:

- wellness from inhaling 21% cleaner, 21% clearer,37% safer 55% fresher and 67% sweeter air without synthetic particulates toxins, acidic and volatile chemicals that protected respiratory function and avoided premature death and acid rain on communities.
- ecosystem security with 95% more forage, food and feedstock for wildlife and human communities.
- supply viability with 0.1% recovered energy, 2.4% recovered biomass, 10% renewable fuel and 16% renewable energy, 27% PCR content, 80% renewable feedstock plus recovery of 80% fuel and 90% feedstock plus 90% water returned to seedlings and ground

Table a. Improved Wellness, Ecosystem and Supply Outcomes/Functional Unit)

Wellness	Results	Supply	Results	Ecosystem	Results
Cleaner Air	0.8µg $PM_{2.5}$	Energy recovery	0.2 MJ ncv	Water to earth	2.2 litres
Clearer air	2.8E-04 g C_2H_2	Recovered fuel	23 MJncv	Viable Biofuel	3.0 MJncv
Toxic-free air	2.4E-07 g 1,4DBE	Renewable energy	4.5 MJ ncv	Renewing feedstock	23 MJ ncv
Fresher IAQ	0.013g NM VOC	Feedstock for reuse	26 MJ ncv	Forage growth	27 MJncv
Sweeter Air	6.1E-03 mol H^+_{eq}	Minerals for reuse	1.2kg	Biodiversity	27 MJncv

Cradle to Cradle Results: Net-zero Outcomes

Table b lists benefits that offset damage to yield net-zero gain or loss including for:

- Wellness via log moisture returned to air and nature space for human rest, recreation & forage
- Climate and Supply security via Carbon sequestered in forest plant, lichen & moss biomass
- Ecosystem fresh forage regrowth for animals, birds, bees, terrestrial forest stock for land dwelling biodiverse fauna & flora wildlife and working humans, arial wildlife stock in forest forage for birds, butterflies, bats, bees, insects & pollinators plus extensive soil to full height forest habitat & forage security plus biodiversity security for wildlife

Table b. Net-zero Wellness, Climate, Ecosystem and Supply Gain or Loss/kg Functional Unit)

Wellness	Results	Climate &Supply	Results	Ecosystem	Results
Air Humidity	1 litre	Photosynthesis	2.5kg CO_{2e100}	Wildlife Range	0.006 m^2/yr
Oxygenation	1.4kg O_2	Food Security	54,000 kJ	Biodiverse Habitat	0.006 m^2/yr

Cradle to Cradle Results: Nature Positive Net-gain

Table c shows net-positive gained exceeding damage and loss in 150% oxygenation to air20-year, near term 20-year embodied carbon 150% climate brake force, 190% forest security via retained biota, seed, fibre & soil biomass plus longer 100 year term 196% Carbon banked in forest soil, roots and biomass.

Table c. Net-gains in Wellness, Climate and Ecosystem Security /kg Functional Unit)

Wellness	Results	Climate	Results	Ecosystem	Results
Climate Brake	3.1 kg CO_{2e20}	Climate Bank	4.9 kg CO_{2e100}	Forest Security	54 MJ ncv

Cradle to Cradle Results: Nature Positive Regeneration

Table d shows net-positive regenerative benefits and gains including for

- Wellness via 200% % photosynthetic oxygen to breathe and Stratospheric Ozone refill,
- climate repair via 200% Carbon drawdown by leaf, algae and microbiota, 248% biomass drawdown
- supply viability 355% water for seedlings, near term 248% Carbon drawdown in forest long term

Table d. Regenerative Human Wellness (HALY/Functional Unit)

Wellness	Results	Supply	Results	Climate	Results
Oxygenation	4.5kg O_2	Water reuse	25l H_20	Climate Brake	6.2 kg CO_{2e20}

Interpretation of Cradle to Cradle LCBA results /kg Functional Unit

These sections report circularity and benefit assessment results ranging from improvement, net zero, net-gain to regenerative.

Unlike linear primary and fossil fuelled operations, inherent benefits arise from reliance on renewable, recycled, reused and or recyclable component circularity in supply.

Improvement ≤100% damage not offsetting loss

Figure 5 depicts improved wellness from cleaner, clearer fresher, safer and sweeter air enabling respiration and visibility. These improvements flow from operations avoiding 21% particulates, 21% summer smog, 55% synthetic volatile chemicals, 37% toxins and 67% acid.

Improved supply charted in Figure 7 is from reliance on:

- renewable 10% fuel, 16% energy and 80% feedstock
- recovered 2.4% biofuel, 27% PCR and 80% fuel
- recoverable 90% feedstock and water to seedlings

Net-zero 100% gain or loss offsets damage

Net-zero gain or loss in supply viability charted in Figure 7 is from 100% log humidity return to air.

Net-zero ecosystem loss charted Figure d reflects forestry 100% sheltering biodiverse wildlife, 100% retained Carbon in plant, lichen & moss, 100% ground for biodiverse fauna & flora and 100% high forage for birds, insects & pollinators.

Nature positive net-gain ≥100% exceeds loss

Net-gain Climate security d in Figure 6 arose from 150% CO_{2e} embodied in certifiably sustainable product and 196% Carbon bank 100 years in forest soil.

Ecosystem net-gain in Figure 7 depicts 190% forest seed, fibre & soil biomass generation 195% forage, food and feedstock biomass generation.

Nature positive regeneration ≥200% gain beyond loss

Regenerative wellness in Figure 5 arises from 200% more photosynthetic Oxygen for breathing and 200% more O_2 flows to and refill Stratospheric Ozone increasing sun-safe time outdoors.

Figure 6 charts regenerative climate security from 248% CO_{2e} drawdown brakes on climate forcing in the near 20 year term.

Figure 7 depicts supply regeneration via 355% freshwater recovery.

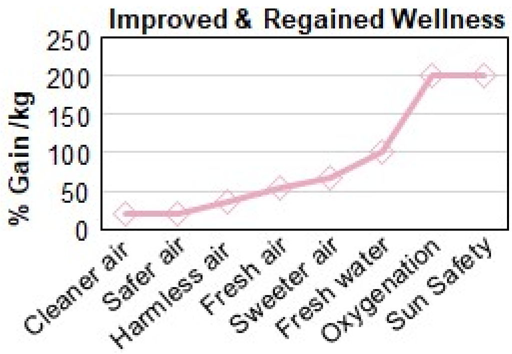

Figure 5 Wellness Outcomes/kg F unit

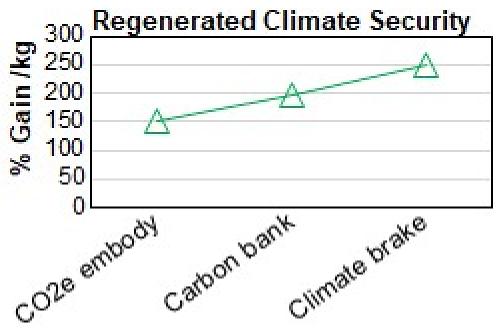

Figure 6 Climate Security/kg F unit

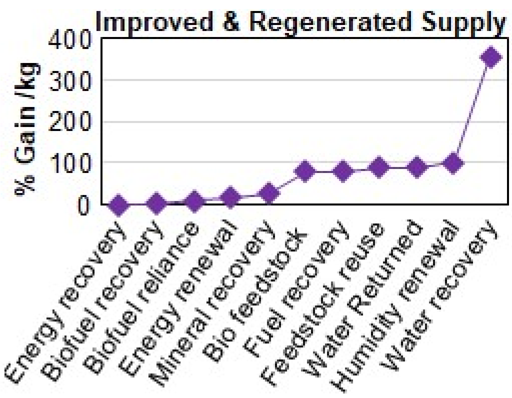

Figure 7 Supply Security/kg F unit

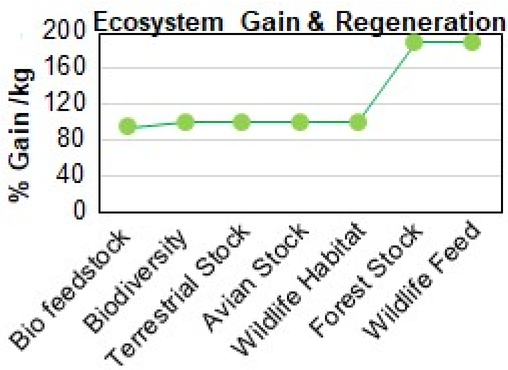

Figure 8 Ecosytem Security/kg F unit

Finally Thermal Haven LCBA and % circularity results coverage across the Nature Positive LCBA framework and UN SDGs is shown in Table e. From a possible 32 it shows 28 results which is an 87.5 % completeness. Missing results were all due to natural and social disasters.

The four results are missing because the LCA period occurred while the COVID epidemic devastated wellness measures in work dignity and access to medical care. Unprecedented nationally-extensive and devastating wildfires and floods also prevented Positive Ecosystem Refill (PERF) measures of:

- Natural access to forests & tracks as some had and still have restricted access;
- Marine stock species richness & range which varied from significantly higher to much lower and
- Urban nature and scarce reserves stocks suffered devastating biodiversity losses.

Table E1 Summary of LCBA results /kg Functional Unit

Benefit Layer	Exposure & Jurisdiction	Unit	Circularity
Healthy Able Life Years (HALY)		**HALY/kg**	**% Capacity**
Clean Air	$PM_{2.5}$ dust-free	µg $PM_{10+2.5}$	21% Decongestion
Sweet Air	VOC free indoors	µg VOC	55% Inhalation
Fresh Food	Affordably nourished	kJ	100% Nutrition
Time in Nature	100 days recreation pppa	R&R Ha	100% R&R space
Fresh Water	Potable rain hydrated	l rain	100% Potabability
Local Shelter	Household shelter	m^2 GFA	200% Housing
Fresh Air	Oxygen indoors	kg O_2	200% Oxygenation
Sun Safety	Ozone layer repair	kg $O_{2\ outdoors}$	200% Ozonating
Supply Energy & Resource Viability (SERV)		**SERV/kg**	**% Capacity**
Viable Mineral	Recycle scarce material	MJ_{ncv}	27% Mineral security
Viable Energy	Reliance on renewable	MJ_{ncv}	80% Renewability
Viable Feedstock	Recycle material & scrap	MJ_{ncv}	80% Recyclability
Viable Supply	Refuel local reserves	MJ_{ncv}	90% Autonomy
Viable Food	Reliance on local food	kJ_{ncv}	95% Food autonomy
Viable Disaster	Reserved sustenance	MJ_{ncv}	95% Recoverability
Viable Shelter	Refuges in disasters	MJ_{ncv}	100% Safe havens
Viable C-bank	Resink Carbon in product	kg CO_{2e100}	150% Bank-carbon
Viable Air	Photosynthetic Cities	kg O_{2e100}	200% Oxygenation
Viable Water	Refill local reservoirs	l_{water}	355% Freshwater
Positive Ecosystem ReFormation (PERF)		**PERF/kg**	**% Capacity**
Plants & Algae	Carbon drawdown	kg CO_{2e100}	100% Climate security
Aquatic Stock	Species rich range	kg frog stock	100% Aquatic bounty
Wildlife Habitat	Corridor & refuge range	MJ biomes	100% Linked Ranges
Terrestrial Stock	Species rich refugia	kg Terrastock	100% Wildlife[9] rich
Arial Stock	Species rich refugia	kg Avistock	100% Abundance
Pollinator stock	Species rich range	kg Beestock	100% Biodiversity
Climate Brakes	Carbon drawdown	kg CO_{2e20}	150% Climate safety
Carbon banking	Soil Carbon	kg CO_{2e100}	196% Soil-Carbon

In conclusion this EPD shows improvement, net-zero, net-positive and some compelling nature positive regenerative results against a background of increasing and devastating natural disasters attributable to anthropogenic climate change. It declares what, where and how nature positive outcomes are imperative for regeneration to secure viable climate and biodiversity on earth in the near and long term future.

---

[9] Most NSW koala sightings are near Port Stephens, Newcastle, Cessnock and Taree. https://hunterlandcare.org.au/fauna-feature-koalas

References Addendum

[16] A Global Goal for Nature, Nature Positive by 2030, About Nature+Positive 2021 https://www.naturepositive.org/

[17] The Partnerships for SDGs online platform. Net Positive in Water & Carbon by 2040. 2022: https://sustainabledevelopment.un.org/partnership/?p=32625

[18] Locke, H., Rockström, J., Bakker, P., Bapna, M., Gough, M., Lambertini, M., Morris, J., Polman, P., & Carlos, M. Nature Positive 2021 The Global Goal for Nature. 2021; pp. 1–21. https://www.nature.org/content/dam/tnc/nature/en/documents/NaturePositiveGlobalGoal.pdf 2022.

[19] Stockholm resilience centre., Planetary boundaries 2022, https://www.stockholmresilience.org/research/planetary-boundaries.html

[20] Cole, R. J. 2015 Net-zero & net-positive design. Build. Res. Inf., 431, pp. 1–6. DOI: 10.1080/09613218.2015.961046

[21] Croes, P.R. & W.J. Vermeulen 2021 The assessment of positive impacts in LCA of products. Int J Life Cycle Assess 261: p. 143-156. DOI 10.1007/s11367-020-01820-x

[22] Vlieg, M., Moazzem, S., Naiker, D., Jones, D. G., 2022. "Quantifying Nature Positive." DOI: 10.20944/preprints 202201.0012.v3

[23] Jones, D, Vlieg, M., Ashar S., Friend, L. & Costa, Gomez C., 2022. "Learning to Quantify Positive Futures." International Journal of Environmental Impacts: 1-18. DOI 10.2495/EI-V5-N2-128-145 WIT Trans. Ecol. Environ 2022, https://www.witpress.com/journals/ei

[24] Vlieg M, Jones D. G. Benefit assessment in LCA, Procs FSLCI LCIC 2020 Conf, Berlin, Session 16. https://www.researchgate.net/publication/359865895

[25] Jones, D. G., Ashar, S., Vlieg, M. A. M., & Baggs, D. M. 2020. Counting Gains to Beyond Zero Impact Futures, WIT Trans. Ecol. Environ 2020; 245, pp. 97-108. DOI 10.2495/EID200101

[26] Vlieg M, Jones D. G. Benefit assessment in LCA, Procs FSLCI LCIC 2020 Conf, Berlin, Session 16. https://www.researchgate.net/publication/359865895

[27] Jones, D. G., Vlieg, A. M., Ashar, S. & Baggs, D. Positive LCA Factoring Planetary Boundaries. Procs 27th SETAC Conf, Brussels, Belgium, pp. 23–32, 2017: https://www.researchgate.net/publication/339815429

[28] Baggs D. M, Jones D., Vlieg M. Ashar S. Driving Beyond LCA Metrics for Net Positive Cities. Procs SETAC Conf Brussels, Belgium, pp. 167–168. 2017

[29] Jones. D., Vlieg, M., Baggs. D.M., Biaz. O. & Bortsie-Aryee. N., Novel Wood LCA & EPDs Procs Conf, pp. 255–256. Helsinki, Finland, 2019. https://www.researchgate.net/publication/339815300

[30] Vlieg M. A. M., Jones D. G. & Ashar S. Forest Product LCA: Carbon Form, Fire, Fuel & Fate Rules. Procs SETAC 2017, pp52, Brussels, Belgium, https://www.researchgate.net/publication/339815272

[31] NSW Department of Primary Industries Fisheries: Survey of recreational fishing, 2019/20 Key Results Technical Report March 2022 NSW Recreational Fisheries Monitoring Program Survey Report No-161 Bureau of Meteorology. (2020). Special Climate Statement 70 update – drought conditions in Australia and impact on water resources in the Murray-Darling Basin. Commonwealth of Australia. https://www.researchgate.net/publication/360773384

[32] Kemter, M., Fischer, M., Luna, L. V., Schönfeldt, E., Vogel, J., Banerjee, A., Korup, O., & Thonicke, K. (2021). Cascading hazards in the aftermath of Australia's 2019/2020 Black Summer wildfires. Earth's Future(9), 1-7. https://doi.org/10.1029/2020EF001884R

[33] Smith, H., Cawson, J., Sheridan, G., & Lane, P. (2011). Desktop review, impact of bushfires on water quality. Australian Government Department of Sustainability, Environment, Water, Population and Communities; University of Melbourne

[34] Huveneers, C., Jaine, F. R. A., Barnett, A., Butcher, P. A., Clarke, T. M., Currey-Randall, L. M., Dwyer, R. G., Ferreira, L. C., Gleiss, A. C., Hoenner, X., SIerodiaconou, D., Lédée, E. J. I., Meekan, M. G., Pederson, H., Rizzari, J. R., van Ruth, P. D., Semmens, J. M., Taylor, M. D., Udyawer, V., Walsh, P., Heupel, M. R., & Harcourt, R. (2021). The power of national acoustic tracking networks to assess the impacts of human activity on marine Survey of recreational fishing in NSW, 2019/20 – Key Results 67 | NSW Department of Primary Industries, December 2021 organisms during the COVID-19 pandemic. Bio Conservation, 256, 1-13. j.biocon.2021.108995 https://doi.org/https://doi.org/10.1016/

[35] Storen, R., & Corrigan, N. (2020). COVID-19: a chronology of state and territory government announcements (up until 30 June 2020), Research paper series, 2020-21, 22nd October 2020. Department of Parliamentary Services, Parliament of Australia

Normative References for this LCA & EPD

ISO 9001:2008 Quality Management Systems Requirements

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

EN ISO 14024:2000 Environmental labels and declarations - Type I environmental labelling-Principles and procedures (ISO 14024:1999)

ISO 14025:2010 Environmental labels and declarations – Type III – environmental declarations - Principles and procedures

ISO 14031:1999 EM: Environmental performance evaluation: Guidelines

EN ISO 14040:2006, Environmental management - LCA - Principles and framework (ISO14040:2006)

ISO 14044:2006 EM: LCA: Requirement & guideline for data review: LCI; LCIA, Interpretation results

ISO14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines

ISO 14064:2006 EM: Greenhouse Gases: Organisation & Project reporting, Validation & verification

ISO 15392:2008 Sustainability in building construction General principles

EN 15643-1:2010, Sustainability of construction works - Sustainability assessment of buildings - Part 1: General framework

EN 15643-2, Sustainability of construction works - Assessment of buildings - Part 2: Framework for the assessment of environmental performance

EN 16449, Wood and wood-based products - Calculation of the biogenic carbon content of wood and conversion to carbon dioxide

ISO 15686-1:2011 Buildings & constructed assets Service life planning Part 1: General principles

ISO 15686-2:2012 Buildings and constructed assets - Service life planning - Part 2: Service life prediction procedures

ISO 15686-8:2008 Buildings and constructed assets - Service-life planning - Part 8: Reference service life and service-life estimation

EN 16449, Wood and wood-based products - Calculation of the biogenic carbon content of wood and conversion to carbon dioxide

ISO 21929-1:2011 Sustainability in building construction Sustainability indicators Part 1: Framework

ISO 21930:2007 Building construction: Sustainability, Environmental declaration of building products

ISO/TS 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

Bibliography

Australian & New Zealand Guidelines For Fresh & Marine Water Quality (2000) http://www.environment.gov.au/water/quality/national-water-quality-management-strategy

Basel Convention (2011) Control of Transboundary Movement of Hazardous Waste & Disposal http://www.basel.int/portals/4/basel%20convention/docs/text/baselconventiontext-e.pdf

International Energy Agency (2022) Energy Statistics http://www.iea.org/countries/membercountries/

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

EcoInvent (2023) LCI Model 3.9.1 database http://www.ecoinvent.ch/ EcoInvent, Switzerland

Evah (2023) LCA Tools, Databases & Methodology at http://www.evah.com.au/tools.html

Franklin Associates (2023) US LCI Database http://www.fal.com/index.html Eastern Research Group USA

GreenTag™ Certification (2023) https://www.globalgreentag.com/about.html

IBISWorld (2023) Market Research, http://www.ibisworld.com.au/ IBISWorld Australia

Plastics Europe (2023) Portal http://www.plasticseurope.org/plastics-sustainability/eco-profiles.aspx

Pre (2023) SimaPro 8 Software, The Netherlands http://www.pre-sustainability.com/simapro-manuals

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

Further and explanatory information is found at

http://www.globalgreentag.com/

or contact:

certification1@globalgreentag.com

Global GreenTag^{CertTM} EPD Program

Environmental Product Declaration

Compliant to ISO 14025