Product Carbon Footprint Declaration

Earth Friendly Concrete (EFC)

GEOPOLYMER CONCRETE

This document is a Type II Product Carbon Footprint Declaration describing Wagners proprietary geo-polymer product Earth Friendly Concrete® in Brisbane, Queensland, AUSTRALIA. The study has been carried out in a method compliant with ISO Standard 14067:2018 (e) – Carbon Footprint of Products, with reference to the Product Category Rules (PCR) for cement.

The Product declaration is certified by The Footprint Company to conform to the Product Category Rule (PCR) referenced below, as well as to the requirements of ISO 14067:2018 (e) and is valid for product produced in Australia, up to and including December 2020.

Product Information	
Reference PCR & ISO Standard	Referenced Product Category Rules For Preparing Product Declaration For Portland, Blended Hydraulic, Masonry, Mortar and Plastic (Stucco) Cements. ISO 14067:2018 (e)
Date of Issue	February 20, 2020
Review was conducted by:	Dr. Caroline Noller – The Footprint Company. Checked: Phil Chenoworth – The Footprint Company

Table of Contents

1. Product Description

This Carbon Footprint declaration covers the proprietary geo-polymer cement blend produced by Wagners Concrete company of Toowoomba, Queensland, AUSTRALIA.

The term, “Geopolymer cement” (GPC) refers to a cement or binder which hardens through a poly-condensation reaction. It contains no General-Purpose Cement (Type GP) and requires an aluminosilicate pre-curser, generally sourced from waste industrial products and an alkaline reagent for “curing”. GPC based concrete maybe formulated to cure more rapidly, gain ultimate strength more rapidly and have higher chemical resistance in hostile conditions as compared to Type GP and or Type GP blend-based concrete.

GPC’s are considered low embodied carbon alternatives to Type GP cements (as defined by the Australian Standard 3972-2010) or a variety of fly-ash and GBBS blends with Type GP, in the production of ready-mix concrete. In addition, GPC is also an opportunity to convert a variety of waste streams (that would otherwise be classified as toxic / hazardous waste to landfill) from electricity and steel production into useful by-products.

Because GPC does not use calcium carbonates as an ingredient, or utilize carbon intensive manufacturing processes, it has substantially less carbon emissions than Type GP based products. The key driver for GPC use in development projects is the desire to mitigate embodied carbon (upfront) emissions arising from the production of concrete products. Depending on the project type, cement and concrete can constitute 5-15% of the total embodied carbon footprint of a typical office building project and significantly more for infrastructure projects.

Wagners Concrete operate several concrete production facilities in South East Queensland and produce a variety of ready-mix and pre-cast concrete products. They also produce a proprietary GPC based concrete branded “Earth Friendly Concrete®” or “EFC®”.

Wagners EFC® is a ground granulated blast furnace slag (GGBS) and fly-ash based binder containing three different chemical products (alkali salts) which together constitute the activator component of the product. This alkali activator, when combined with water, GGBS and fly-ash form a geopolymer reaction. The product is either sold as a dry pre-mix powder or as a ready-mix concrete or precast concrete product.

2. Goal and Use of this Declaration

The goal of this assessment is to present the estimated embodied carbon emissions of a declared unit of product, in kilograms of carbon dioxide equivalent (GWP), for the scope of cradle-to-final production factory gate (A1-A3 - EN15804). It is also to provide a comparison to Type GP alternatives.

The use of the information is limited to the appreciation of the Functional Unit product value and comparative product assessment at the discretion of the User. The comparative analysis of equivalent ready-mixed concrete blends is relevant to the temporal and geographic limits described in the section 3 – Life Cycle Methodology.

This Carbon Footprint Declaration for Wagners EFC® is specific to product produced at their facility located in Brisbane, Queensland, Australia. Completed in accordance with the Study Methodology set-out in Section 3.

3. Carbon Footprint Methodology

LCA Method Element	Carbon (climate declaration) life cycle assessment
Principle Methodology	Hybrid Life Cycle Footprint Assessment The inclusion of Wagners Concrete scope 3 (corporate indirect operations) (combination of process measure of physical quantities combined with financial value to achieve completeness).
Assessment Goal	Estimate carbon (GWP) emissions associated with the defined function unit of Earth Friendly Concrete. Provide a comparison to alternatives on a functional unit basis to provide an indication of environmental benefit.
Scope	Cradle to Gate (A1-A3) with possible extension to Construction (A4 & A5)

Product Stage			Construction Stage		Use Stage							End of Life Stage				Recovery
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1
Raw material sourcing	Transport	Manufacturing	Transport	Installation	Material Emissions	Maintenance	Repairs	Replacement	Refurbishment	Operating Energy	Operating Water	Demotion	Transport	Waste Processing	Disposal	Re-Use
Included	Included	Included	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Study Limits	Limited to the assessment of a Proprietary Blend of Wagner EFC
Scope Exclusions	A4 - Final transport from batching plant to site A5 - Construction placement B - Use Stages C - End-of-life D - Recovery
Referenced Standards	ISO 14025 / EN 15804 / ISO 14067-2018
Reported Impact Indicators	GWP / Carbon Emissions/ Upfront Carbon / Embodied Carbon
Study Boundary	Generally, site boundary or defined control including capital materials and annual operational inputs for a nominated study period - unbounded.
Functional Unit	Functional Units for the purposes of comparability are: 1. One (1) Metric Tonne of dry mix EFC 2. One (1) cubic meter (m3) of ready-mix concrete - in the blends nominated
Inventory	Life Cycle inventories utilised in this study include:- - The Footprint Company proprietary LCI and database - University of Melbourne, EPiC database - Aus LCI / ICE V3.0 - Published Product Declarations from nominated sources. - Other various published inventories and peer reviewed sources referenced.
Data Sources	Primary data for mix design and principle product constitution. Secondary data sources for transport distances.
Geographic & Temporal Relevance	Australian application - Queensland and valid at 30 June 2019 and for 2 years from the date of publication.

3. Carbon Footprint Methodology – cont'd

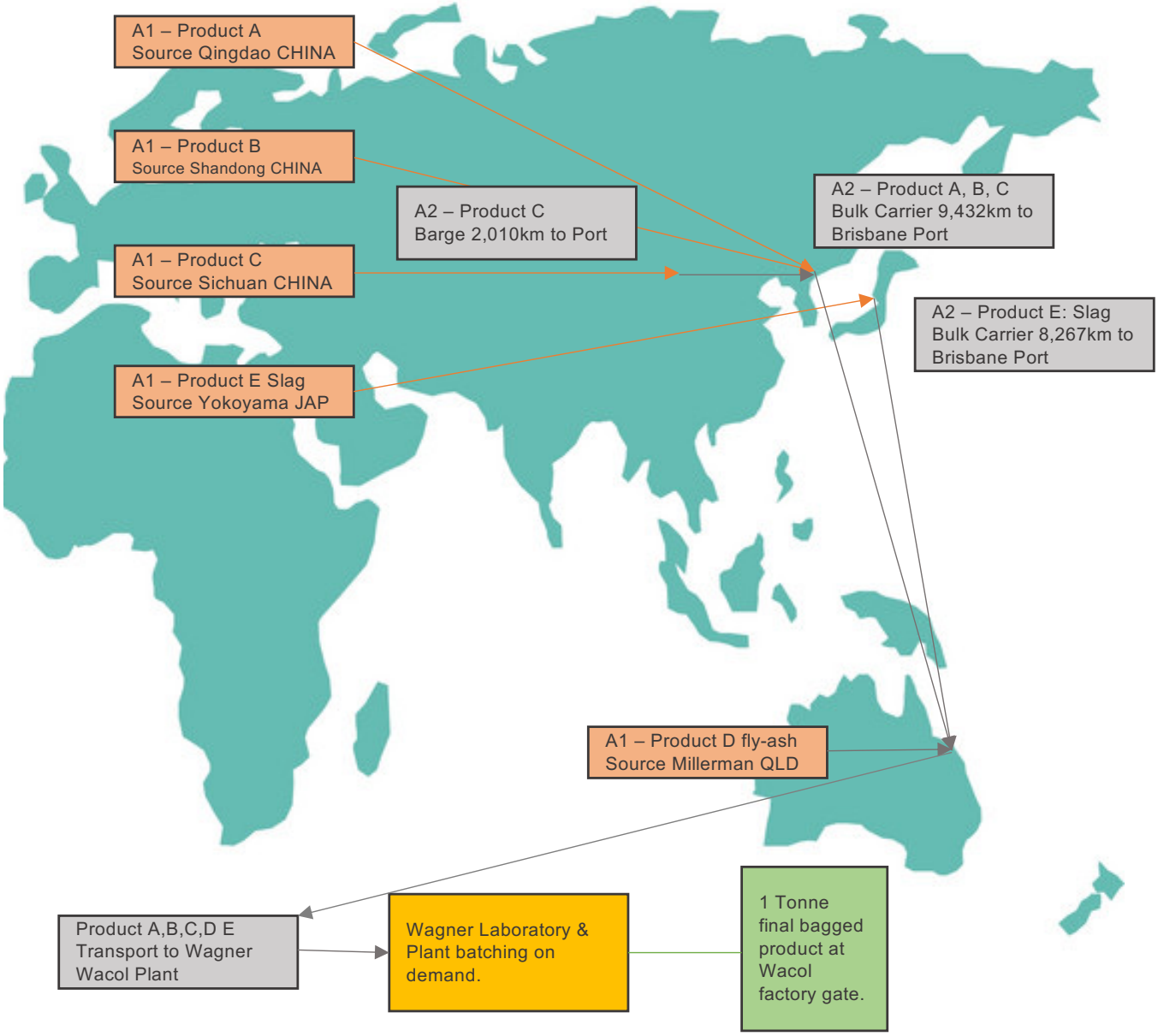
Unit Process and Flow

The figure below outlines the unit processes included within this assessment. The primary production of Product A-C is included, and China relevant LCI sources are used for these products as far as possible.

Intermediate transport processes and distances are shown. Refer to Table 4.3 for further details. Intermediate shipping by carrier type by distance is included.

Final batching of principle products including all direct energy at plant as well as indirect capital and operational impacts arising from the corporate entity and plant is included in A3.

A4-A5 are EXCLUDED from this assessment due to the uncertain nature of the distance / location or final place of construction for Wagner EFC®. Users are to make their own assessments in this regard.



4. Results

Functional Unit

To meet the requirements of this declaration the absolute total carbon emissions in kilograms is required as is an expression of the relative intensity in a meaningful function unit.

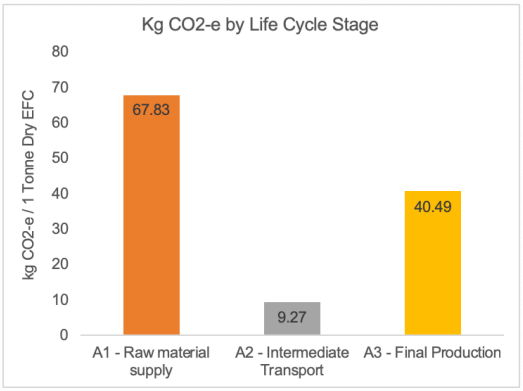
Table 4.1 – Declared Values per Functional Unit

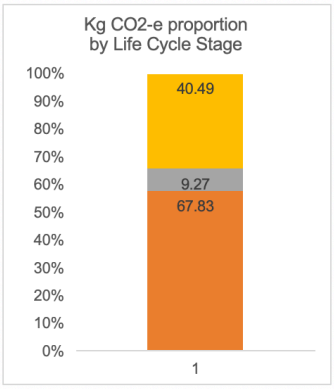
Product	Functional Unit	Units	Declared Value (metric)
Wagners EFC® geopolymer cement	1 Tonne of dry product	GWP Kg CO_2-e / T	117.59
N32 EFC® Ready Mixed Concrete	1 m3 of ready-mix product	GWP Kg CO_2-e / m3	122.59

Table 4.2 – Kg CO_2-e By Life Cycle Stage

A1 - Raw material supply	67.83
A2 - Intermediate Transport	9.27
A3 - Final Production	40.49
Total A1-A3 kg CO2-e / 1 T EFC®binder	**117.59**

Figure 4.1 – Kg CO_2-e By Life Cycle Stage





57.7% of the total Kg CO_2-e per unit are associated with the virgin binder products A, B and C.

Fly-ash and slag are allocated no emissions footprint as they are defined as "industrial waste" products.

Transport emissions of all binder products, including fly-ash and slag, are accounted for and allocated in A2 and account for a total of 7.9% per Tonne of GPC.

A3 final production is inclusive of all "indirect" emissions arising from the operations of the Wagner Concrete business, which have been included on a financial basis from audited financial accounts.

Production Process

Wagners EFC®-binder contains three different chemical products that are the chemical activator component of the geopolymer binder. The blend is proprietary and subject to a Trade Secret.

The three chemical products are referred to in this report as Type A, Type B and Type C and are all sourced from China.

Fly-ash is sourced locally in Queensland and slag is sourced from Japan.

Table 4.3 – Transport A2 – Source Statement

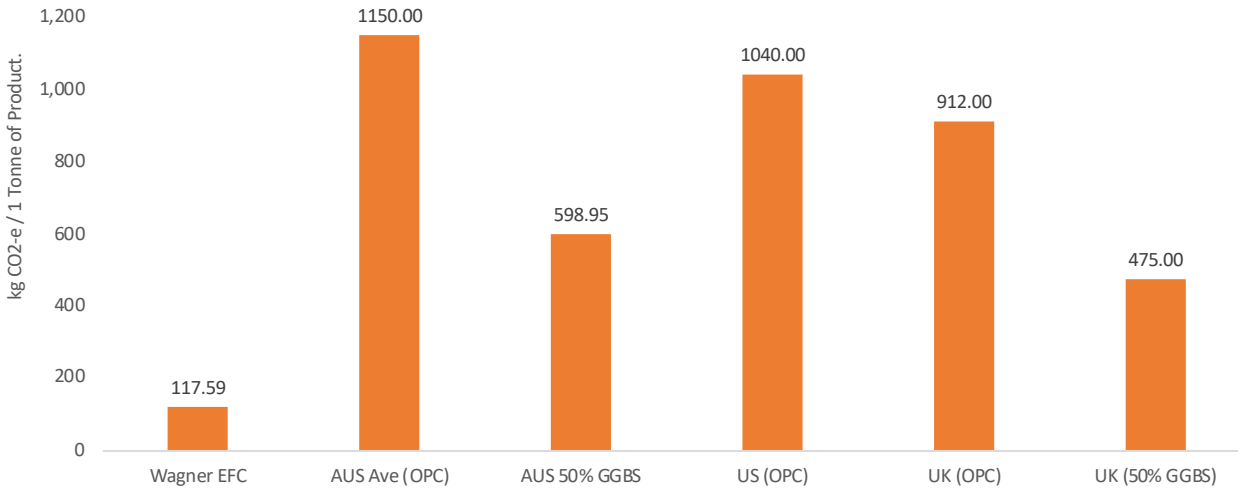
EFC Component	Country of Origin	Location	A2 Mode	VKT
Type A	China	Qingdao	Road	15 km
			Bulk Carrier	9,432 km
			Road	5 km
Type B	China	Shandong	Road	266 km
			Bulk Carrier	9,432 km
			Road	5 km
Type C	China	Sichuan	Barge	2,010 km
			Bulk Carrier	8,778 km
			Road	5 km
Fly-Ash	Australia	Millmeran	Road	82 km
Slag	Japan	Okoyama	Road	5 km
			Bulk Carrier	8,267 km
			Road	5 km

5. Comparative Analysis

The core objective and purpose of Life Cycle Assessment is to establish the environmental impact of a declared unit of product and to identify possible pathways to improve reduce it. It also has a role in communicating in a comparative fashion, its impact against other similar products. The objective is to inform Users as to the environmental benefit. This section presents a comparative analysis of both Wagner EFC® products against International and local alternatives.

IMPORTANT NOTE: Wagner EFC® results are derived from a hybrid LCA method which is extended to *include Scope 3 (i.e. indirect impact of Wagner operations*). Other product values shown are based on *unit process analysis and excluded Scope 3*. For Wagners EFC®, Scope 3 emissions were estimated to account for 32-34% of total emissions. To this end, the hybrid LCA method should be considered as having a higher level of "completeness" than the alternative unit process based comparative values.

Figure 5.1 – Comparative Analysis Wagner EFC® vs Regional Cement Blends per Tonne



Sources: Australian OPC and 50% GGBS ; are averages of Aus LCI and EpiC Database / US OPC – American Cement Manufactures EPD, 2016 / UK OPC and 50% GGBS – ICE DBE V3.0 2019.

Figure 5.1 shows Wagner EFC® GPC as having the lowest embodied carbon intensity per 1 Tonne of dry binder product as compared to the comparative sample shown. For the Australian setting, the use of Wagner EFC® GPC is estimated to deliver up to 89.9% reduction in embodied carbon emissions as compared to Australian average OPC and 80.4% as compared to 50% GGBS; 88.7% and 87.1% reduction as compared to UK and US OPC respectively and 75.2% when compared to UK 50% GGBS alternative.

The comparison of 1 Tonne of dry binder is instructive as to the magnitude of benefit presented by Wagner EFC® GPC as compared to traditional and currently accepted dry product alternatives. It is also helpful to compare one cubic meter (m3) of equivalent grade ready-mix concrete (A1-A3) to provide the User with a sense of the emissions advantage for adopting Wagner EFC® GPC ready-mix. Figure 5.2 presents a comparative analysis of the embodied carbon footprint (in Kg CO_2-e) per cubic meter of N32 MPa (Type GP) ready-mix concrete in the same geographies as shown in Figure 5.1.

The values declared are for a cubic meter of N32 strength grade concrete including cement, coarse and fine aggregates, water and ad-mixtures using the same inventory sources as noted for Figure 5.1 above.

Figure 5.2 – Comparative Analysis Wagner EFC® vs Regional 1 m3 of N32 MPa Ready-mix Concrete

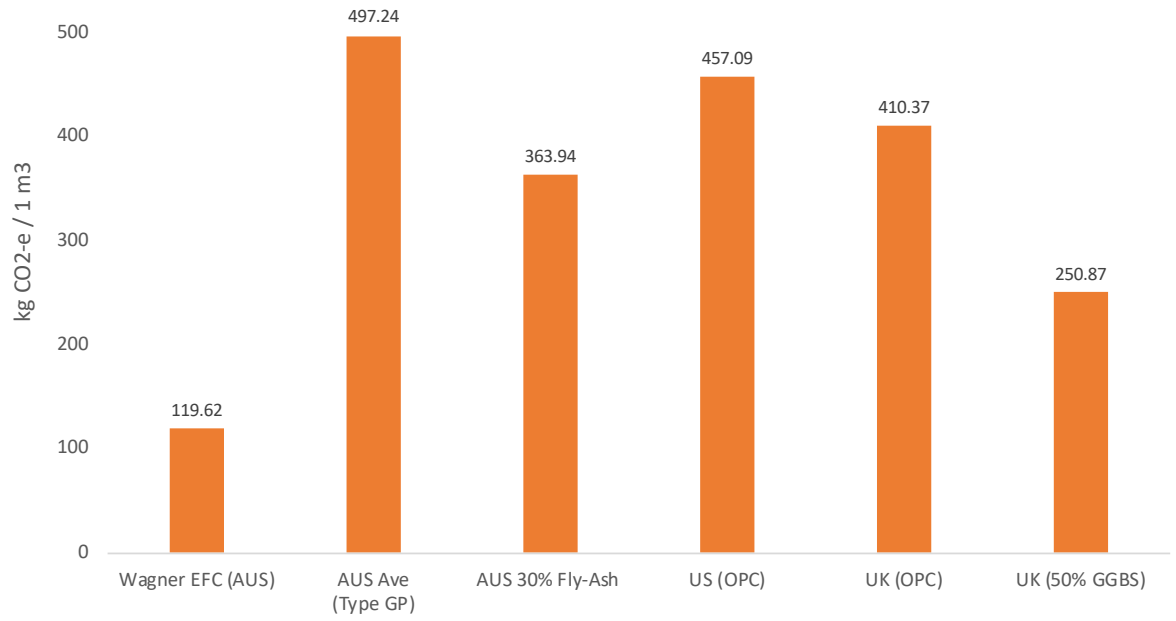


Table 5.1 –1 m3 of N32 MPa Ready-mix Concrete – Values and Sources

COMPONENT	*Wagner EFC (AUS)*	*AUS Ave (Type GP)*	*AUS 30% Fly-Ash*	*US (OPC)*	*UK (OPC)*	*UK (50% GGBS)*
		EPiC & CSIRO Hybrid LCI	TFC Proprietary LCI & others	American Cement, EPD 2017	ICE V3 2019	
1 m3 of Ready Mix N32	119.62	497.24	363.94	457.09	410.37	250.87
TOTALS	**119.62**	**497.24**	**363.94**	**457.09**	**410.37**	**250.87**

Figure 5.2 and Table 5.1 demonstrates Wagner EFC® GPC S32 (equivalent) ready-mix has the lowest embodied carbon intensity per cubic meter (m^3) amongst the alternatives presented. For the Australian setting, the use of Wagner EFC® is estimated to present 75.5% reduction in embodied carbon emissions against Australian average using OPC; 67% as compared to 30% Fly-ash replacement; 73.3% and 70.3% reduction as compared to UK and US OPC respectively and 51.5% when compared to UK 50% GGBS alternative.

Table 5.2 shows the material composition for the S32MPa mix design declared and shown in Figure 5.2.

This Carbon Footprint Declaration is for the Life Cycle Stages of Cradle (A1) to Gate (A3) inclusive of all intermediate transport (A2) emissions arising for the two declared functional product units.

NOTE: The composition of ready-mix concrete suffers a high degree of variability and is generally region and project specific. It is normal to see binder / fly-ash / aggregate variance of +/-10% by mass per ingredient amongst the different strength options. Modelling of blends, can show a 10% +/- overall variance in total embodied carbon intensity. This should be considered by the report User.

Table 5.2 S32 MPa Ready-mix Concrete

EFC S32_20_150 (Wacol) SLAB DESIGN		
Material	**Qty**	**Unit**
Geopolymer binder	392.00	kg
20 mm	668.00	kg
10 mm	349.00	kg
Med sand	428.00	kg
Fine sand	381.00	kg
PF 4100	2.00	L
Water	185	L

The Life Cycle Stages A4 (final transport to site) and A5 (final construction) have been EXCLUDED on the basis that the road distances from plant gate to site and construction methodology on site are subject to an unacceptably high level of alternative possibilities to provide an adequate level of accuracy.

The User of this report, should make their own assumptions on the modes and distances of A4 and A5, in order to achieve a project specific absolute final value and or quantum of carbon benefit for the use of EFC® GPC and EFC® ready mix concrete.

For the purposes of this Carbon Footprint Declaration, the consistent material composition of the assessed product is shown in general terms only. The exact Wagner EFC blend assessed as part of this declaration is protected by a Trade Secret and is commercially sensitive. Further enquiries should be directed to Wagners at: tom.glasby@wagner.com.au

6. Data Sources, Quality & Accuracy Statements

Table 6.1 gives a summary of the life cycle inventories and information sources used to prepare this assessment, along with its source and a statement of quality and accuracy.

Table 6.1 – Life cycle inventories and data sources

Study Aspect	Sources	Quality	Accuracy / % Completeness
Materials Life Cycle Inventories	▪ Proprietary LCI database of TFC (Hybrid) ▪ AUS LCI (unit process) ▪ ICE 3.0 (unit process) ▪ EPiC LCI (Hybrid) ▪ National IO LCI (Input-output) ▪ Other cited LCI references ▪ Industry Sector Published LCI	High Med-High Med-High Med-High High Med	~ 85% 75-85% ~80% ~85% ~90% 75-85%
Operational Energy	▪ National Greenhouse Accounts Factors 2019	High	85% +
Transport Emissions per KMt	▪ Sustainable Freight Organization ○ International shipping calculators ○ Road freight calculators.	Medium	70%+
Scope 3	▪ Financial data sourced from Wagner public financial accounts 2018-2018. ▪ EFC® production data provided by Wagners for determination of Scope 3 allocation to EFC®. ▪ Greenhouse coefficient for A$1 of final demand based on National IO estimates Deloitte Access Economics.	High	85% +
Principle materials data for EFC®	▪ Sourced from Wagner from contracted suppliers as specified in inventory tables.	High	85%+

7. Reference Standards

The Standards referred to for this assessment are listed below.

Reference International Standards
ISO 14026:2017 Environmental labels and declarations
ISO 14044:2019 Environmental Management – Life cycle assessment
ISO 14067:2018(E) Carbon Footprint of Products
EN 15804:2012 Sustainability of Construction Works

8. Other Sources and References

In addition to the publish and proprietary life cycle inventories used for the purposes of this study, the following other references are cited and used in this assessment.

Reference	Author	Date
Portland Cement Environmental Product Declaration	PCA America's Cement Manufacturers	June, 2016
Life Cycle Inventories for the Production of Sodium Silicates.	Fawer.M, Concannon. M, Rieber. W	1999
LCI data for the calculation of GHG emissions of N, P and K.	Kool. A; Marinussen. M, Blonk. H	2012
False Values on CO2 Emission for Geopolymer Cement / Concrete	Davidovits. J	2015
Costs and carbon emissions for geopolymer pastes in comparison to ordinary portland cement	McLellan. B C, et.al	June, 2011

9. Verification Statement

The Author confirms that in accordance with the limits of the scope of our appointment, we have sufficient knowledge and expertise of the product category, industry structure, relevant standards and geographical area sufficient to carry out and issue this Declaration.

The Author confirms that we are satisfied with the company (Wagners) and product specific data provided is plausible and consistent with the requirements. The Author confirms that we have been independent in our role as LCA assessor and are satisfied generally with the findings in terms of:-

- The underlying data provided, collected and used for the LCA calculations,
- The application and execution of the LCA calculations and their consistency with the calculation rules,
- The presentation of the findings and performance (noting the presentation of values in an industry User friendly notion – and its deviation from strictly scientific notion) and
- The other information included in the Declaration.

The Declaration owner is responsible for the factual integrity and source data provided and that the product, as represented in this Declaration, does not violate relevant legislation.

Name and organization of Author:	The Footprint Company : Dr. Caroline Noller
Date and location:	**4 April, 2020 : Australia**
Signature:	*Dr. C Noller*