EGGA
European General Galvanizers Association

BATCH HOT DIP GALVANIZING OF STEEL PRODUCTS TO EN ISO 1461

EUROPEAN AVERAGE

EPD
THE INTERNATIONAL EPD® SYSTEM

ECO PLATFORM EPD EN 15804 VERIFIED

BASED ON:	REVISION:	CERTIFICATION N°:	ECO EPD REF. N°:
PCR 2011:16 Corrosion protection of fabricated steel products, Version 2.2, 2016-07-01 and EN: 15804:2014	1.1	S-P-00915	00000421
CPC CODE:	**VALIDATION DATE:**	**VALID UNTIL:**	
88731	12/09/2016	11/09/2021	

EGGA
European General
Galvanizers Association

European General Galvanizers Association (EGGA) is the industry organization for Europe's general galvanizing sector. It is a federation of the National Associations of most of the European Union Member States together with the associations of Norway and Turkey. National Associations represent over 600 general galvanizing plants.

In 2016, EGGA developed a Pan-European Life Cycle Inventory (LCI) study of an average galvanized steel product.
The final result of that work was a life-cycle inventory data set for the batch galvanizing process, sometimes known as 'the service', based on data submitted by members of EGGA National Associations (NAs) from their own operations according to ISO 14040/14044. The average energy, resource consumption and emission of substances to the environment, resulting from a LCI of a representative sample of plants operating at European level, have been calculated according to the defined system boundaries.

The Galvanizing service

Hot dip galvanizing is one of the most popular treatments for steel corrosion protection and can be applied to a wide range of steel products that are characterised by many different dimensions, geometries and functions. The operational sequence of the plant is essentially the same and the dimension of the kettles (i.e., the bath of molten zinc) is determined by the typical mix of products to be coated. For example, small components are normally processed by companies operating smaller kettles.

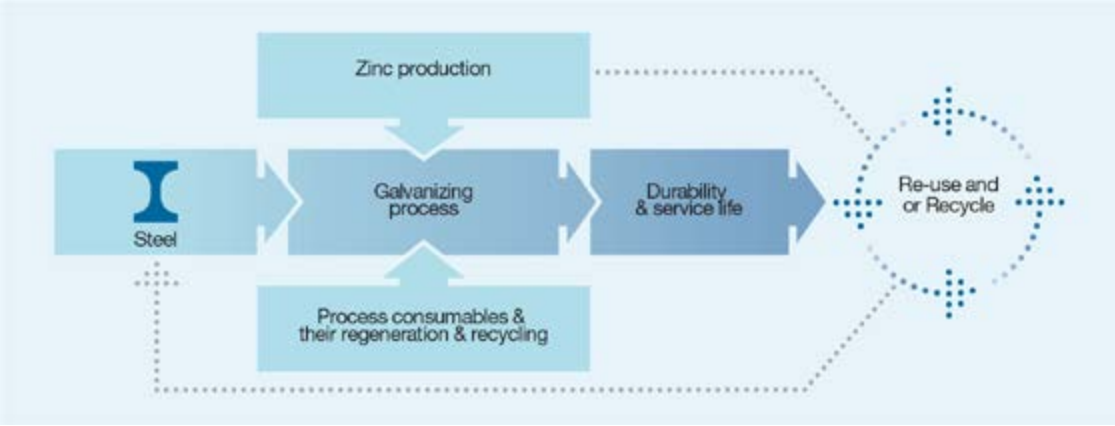
Galvanizing is a **corrosion protection process for steel**, in which the steel is coated with zinc to prevent it from rusting. The process involves dipping cleaned iron or steel components into molten zinc (which is usually at around 450°C). A series of zinc-iron alloy layers are formed by a metallurgical reaction between the iron and zinc creating a strong bond between steel and the coating. A typical time of immersion is about four or five minutes, but it can be longer for heavy articles that have high thermal inertia or where the zinc is required to penetrate internal voids. Upon withdrawal from the galvanizing bath, a layer of molten zinc will be deposited on top of the alloy layer stopping corrosion of steel in two ways- a physical barrier and electrochemical protection. Typical coating thicknesses can range from 45µm to over 200µm and in case of damaged area, a galvanic cell is formed: the zinc around the point of damage corrodes in preference to the steel and forms corrosion products that precipitate on the steel surface and protect it.

The hot dip galvanized coating is applied according to the requirements of **EN ISO 1461**.
The life of the coating varies dependent on the exposure conditions and, for most situations can be estimated using **EN ISO 14713-1**.

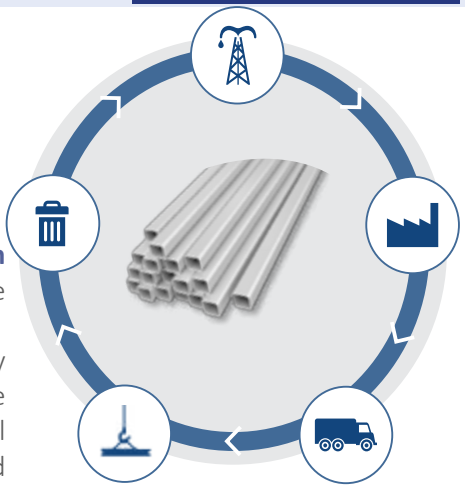
LCI data is a vital tool for the detailed study of the life-cycle environmental impacts of products and services. However, LCI data is not easy for product users to interpret and it is now increasingly common to communicate environmental performance through the simpler format of an environmental product declaration (EPD).

This EPD presents the impact of the galvanizing service for the notional steel product defined by the PCR for a sectoral EPD - a steel plate of 1m^2 of 8 mm thickness.

Hot dip galvanizing is a service of corrosion protection that may be supplied from a variety of operators that will not be identifiable at the specification stage in, for example, construction projects. A strictly 'corporate' EPD may therefore be less useful for this type of corrosion protection service. Against this background, the European General Galvanizers Association (EGGA) appointed the Italian consultancy, Life Cycle Engineering, to generate a **'sectoral' EPD** for the hot dip galvanizing of steel products.



Methodology



This EPD is a sectoral EPD referring to a European sample covering more than **1 million tonnes (~19%) of the production within EGGA's membership**. Data were collected from **66 companies in 14 countries** for plants that were deemed highly representative of the European industry.
Data collection used a web-based questionnaire tool developed by LCA experts under the supervision of hot dip galvanizing industry experts within EGGA. The sample was defined to cover relevant countries and processes with a goal of achieving a representative sample of the production, considering a range of **heavy, medium and light products** production with a small contribution of centrifugal process. Zinc kettles are mainly heated by natural gas with a small number heated by electricity or LPG. Inconsistencies in submitted data were carefully screened and resolved by detailed interaction with the participating companies.
It is important to observe that the process generates, beyond the corrosion protection of steel products, two other outputs: hard zinc (dross) and zinc ashes, that are both considered as a by-product with a mass allocation (e.g. raw material for zinc oxide production).

For LCI and EPD purposes, the 'system' is therefore a **service of corrosion protection for steel products by hot dip galvanizing**, characterised by a given amount of zinc on the surfaces of the steel product depending mainly on the product characteristics (e.g. steel thickness). This EPD is based on the average zinc coating thickness required by EN ISO 1461.

The measure of the environmental performance was performed, in accordance with rules provided by the International EPD® System: **PCR 2011:16 "Corrosion protection of fabricated steel products"** version 2.1 and according to International Standard ISO 14040 Series on Life Cycle Assessment.

The declared unit (the reference unit to which results are related) is set by the PCR. Data are presented for 1 year of protection of 1 m^2 steel plate of 8 mm thickness, calculated on the basis of the **life span predicted using EN ISO 14713-1**.

Substrate	steel plate of dimension 1m x 1m x 8mm and weight 62.4 kg
Galvanized coating thickness	85 microns (2% in mass)
Exposure environment	Category C3 (as defined in PCR) with average zinc corrosion rate of 1.35 microns/year
Predicted maintenance-free coating life	Minimum of 63 years
Units (results)	Burdens per year of protection

Data presented include both steel product (EU plate dataset from World Steel Association, not considering a burden for scrap input or a credit for the EoL recycling) and hot dip galvanizing process. Allocation of recycling credits for either steel or galvanizing process waste recovery are stated separately (Module D). The reference database for secondary data is Ecoinvent 2.2, except for specific dataset as reported on page 6. Electricity mix is defined according to the specific countries where the plants are located, except for SHG zinc and steel plate referring to specific eco-profiles.

The highest contributor to variability within the results is from the direct energy consumption of the galvanizing process (standard deviation 1σ = 24%). Other parameters have only slight influence on variability.

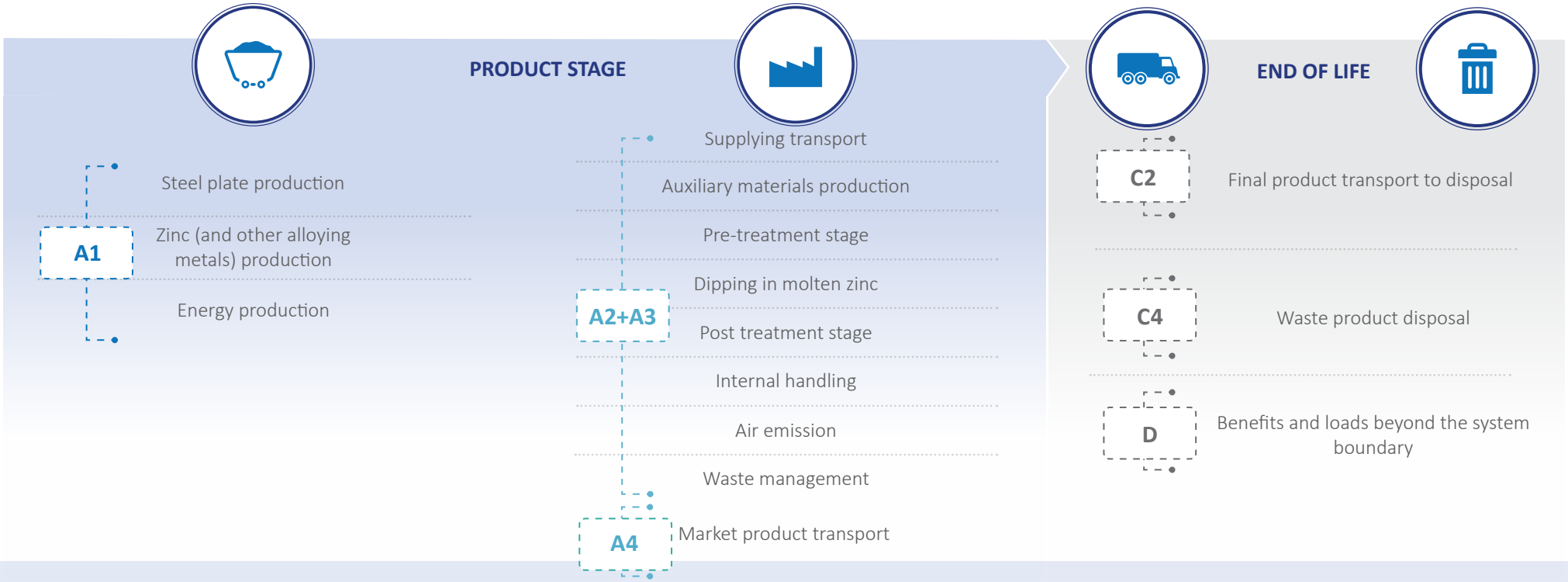
System boundaries

A simplified scheme of hot dip galvanizing process for steel plate is presented, in which the main activities included in the system boundaries are listed.

Under normal conditions, galvanized steel product installation, maintenance and demolition/deconstruction will not have relevant material or energy consumption. Also product waste processing is not relevant since coated steel product at the end of its life do not need any treatment before recovery/disposal processes.
The scope of this EPD is "cradle to gate with options".

For this reason modules from A5 to B5, C1 and C3 are not included (X refers to considered stage, NR refers to not relevant stages (A5-C1 as declared in the PCR and C3, not necessary for declared product).

Product stage			Construction process stage		Use stage							End of Life				Resource recovery stage
Raw materials	Transport	Manufacturing	Transport	Construction-Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction - demolition	Transport	Waste processing	Disposal	Reuse- Recovery - Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	NR	NR	NR	NR	NR	NR	NR	NR	NR	X	NR	X	X



Product stage

A1 - Raw Materials Supply

Steel plate production and steel transport to galvanizing plant (data from World Steel Association: EU plate dataset from, not considering a burden for scrap input or a credit for the EoL recycling).

Specific secondary materials pre-treatments, where appropriate.

Production of metal and alloy elements (SHG Zinc data from International Zinc Association).

Scheme of the considered system boundaries

Generation of electricity and other fuels from primary and from secondary energy resources (excluding waste treatments).
Electricity data come from International Energy Agency, Blue book 2015

Product stage (Galvanizing process)

A2 - Raw material transport

Raw materials transportation from production or collection facilities to the production plant and internal transportation.

Auxiliary materials production for pre and post treatment stages .

Scheme of the considered system boundaries (core processes).

Hot-dip galvanizing process, including utilities.

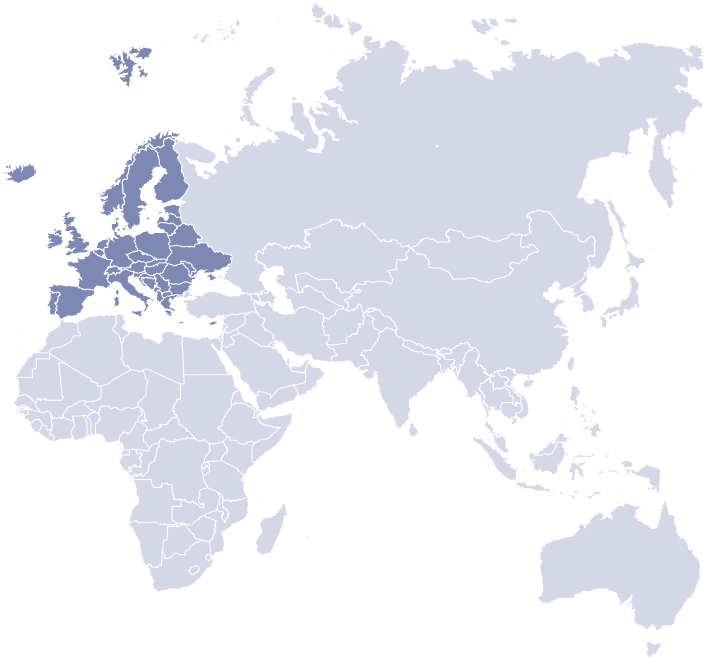
Treatment of waste generated from the galvanizing process.

A3 - Manufacturing (galvanizing process)

Transports

A4 - Distribution

Transport to the customers (general market average).
Distances estimated considering 100 km from the plant to client location.



C2 - Product transport to disposal

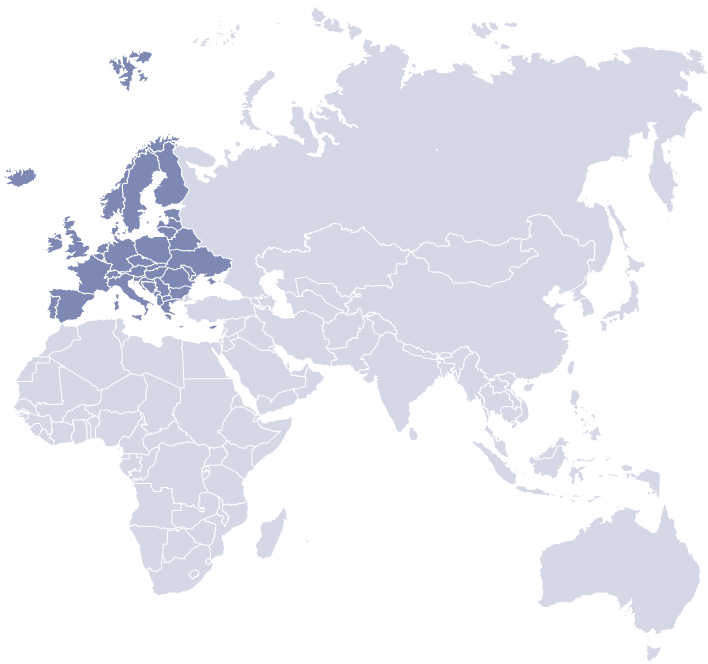
Transport to the recovery/disposal point.
Distances estimated considering 50 km from the dismantling location to recovery/disposal facility.

End of Life and recycling

Recycling rate of steel construction product is about 83%, based on work carried out by World Steel Association.

Galvanized steel is fully recyclable, keeping the same high quality when recycled.
Recycling routes are well established and recycling is therefore the preferred end-of-life route.

C4 - Product waste disposal



D - Benefits and loads beyond the system boundary (of the galvanizing process)

Environmental Performance

The detailed environmental performance (in terms of use of resources, pollutant emissions and waste generation) is presented for sub-phases A1-A3, A4, C2, C4, D.
The numbers reported in the following tables are the outcome of rounding. For this reason total results could slightly differ from the sum of contributions of the different phases.
The galvanizing contribution to the manufacturing phase and final product transport (A1-A3 + A4) is reported in the last column, according to the same declared unit.

RENEWABLE RESOURCES	MANUFACTURING		END OF LIFE		D	Contribution from galvanizing process [EN ISO 1461]
	A1 - A3 Product stage	A4 Distribution	C2 Product Waste transport	C4 Product Disposal	Benefits and loads beyond the system boundary*	
Use of RENEWABLE primary energy excluding renewable primary energy resources used as raw materials [MJ, net calorific value]	0.05	<0.01	<0.01	<0.01	0.39	0.05
Use of RENEWABLE primary energy resources used as raw materials [MJ, net calorific value]	0.02	<0.01	<0.01	<0.01	0.08	0.02
Total use of RENEWABLE primary energy resources (primary energy and primary energy resources used as raw materials) [MJ, net calorific value]	0.07	<0.01	<0.01	<0.01	0.47	0.07

*The main contributor to "D" module is recycling of steel plate with minor additional contributions from recovered substances from within the galvanizing process.

NON-RENEWABLE RESOURCES	MANUFACTURING		END OF LIFE		D	Contribution from galvanizing process [EN ISO 1461]
	A1 - A3 Product stage	A4 Distribution	C2 Product Waste transport	C4 Product Disposal	Benefits and loads beyond the system boundary*	
Use of NON-RENEWABLE primary energy excluding non-renewable primary energy resources used as raw materials [MJ, net calorific value]	28.59	0.14	0.14	0.01	-7.16	1.85
Use of NON-RENEWABLE primary energy resources used as raw materials [MJ, net calorific value]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total use of NON-RENEWABLE primary energy resources (primary energy and primary energy resources used as raw materials) [MJ, net calorific value]	28.59	0.14	0.14	0.01	-7.16	1.85

NET USE OF FRESH WATER	MANUFACTURING		END OF LIFE		D	Contribution from galvanizing process [EN ISO 1461]
	A1 - A3 Product stage	A4 Distribution	C2 Product Waste transport	C4 Product Disposal	Benefits and loads beyond the system boundary*	
Net use of fresh water [m^3]	14.69	0.01	0.01	<0.01	-1.64	1.32

*The main contributor to "D" module is recycling of steel plate with minor additional contributions from recovered substances from within the galvanizing process.

USE OF SECONDARY RESOURCES	MANUFACTURING		END OF LIFE		D Benefits and loads beyond the system boundary*	Contribution from galvanizing process [EN ISO 1461]
	A1 - A3 Product stage	A4 Distribution	C2 Product Waste transport	C4 Product Disposal		
Use of secondary material [kg]	0.11	<0.01	<0.01	<0.01	0.83	<0.01
Use of renewable secondary fuels [MJ]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Use of non renewable secondary fuels [MJ]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

WASTE PRODUCTION AND TREATMENT	MANUFACTURING		END OF LIFE		D Benefits and loads beyond the system boundary*	Contribution from galvanizing process [EN ISO 1461]
	A1 - A3 Product stage	A4 Distribution	C2 Product Waste transport	C4 Product Disposal		
Hazardous waste disposed [kg]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Non-hazardous waste disposed [kg]	0.01	<0.01	<0.01	<0.01	<0.01	0.01
Radioactive waste disposed/stored [kg]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

*The main contributor to "D" module is recycling of steel plate with minor additional contributions from recovered substances from within the galvanizing process.

ENVIRONMENTAL IMPACT PARAMETERS	MANUFACTURING		END OF LIFE		D Benefits and loads beyond the system boundary*	Contribution (included) from galvanizing process [EN ISO 1461]
	A1 - A3 Product stage	A4 Distribution	C2 Product Waste transport	C4 Product Disposal		
Global Warming Potential, GWP [kg CO_2 eq]	2.58	0.01	0.01	4,12E-04	-1.20	0.12
Ozone Depletion Potential, ODP [kg CFC-11 eq]	1.12E-08	1.61E-09	1.58E-09	5.31E-11	4.80E-08	1.28E-08
Photochemical Ozone Creation, POCP [kg C_2H_4 eq]	1.02E-03	1.00E-06	1.00E-06	7.56E-08	-5.23E-04	3.50E-05
Acidification Potential, AP [kg SO_2 eq]	5.33E-03	6.00E-05	5.90E-05	3.00E-06	-9.64E-04	1.05E-03
Eutrophication Potential, EP [kg PO_4^{3-} eq]	9.00E-05	1.40E-05	1.30E-05	1.00E-06	2.78E-04	9.30E-05
Depletion of abiotic resources-elements, ADP-elements [kg Sb eq]	1.20E-05	1.31E-11	1.29E-11	6.89E-13	1.65E-07	1.19E-05
Depletion of abiotic resources-fossil, ADP-fossil fuels [MJ]	27.98	0.14	0.14	5.60E-03	-9.24	1.55

*The main contributor to "D" module is recycling of steel plate with minor additional contributions from recovered substances from within the galvanizing process.

SCIENTIFIC NOTATION is a way to express numbers that are too small to be conveniently written in decimal form.. All numbers written in this notation are in the form m × En (m times ten (E) raised to the power of n). Example: 1.02E-03 is equal to 1.02 x 10^{-3} = 1.02 x 0.001 = 0.00102

Reference

This declaration has been developed referring to the International EPD® System, following the General Program Instruction and Supporting Annexes (rev. 2.5 -2015/11/05) and PCR 2011:16 "Corrosion protection of fabricated steel products" version 2.1; further information and the document itself are available at: www.environdec.com.

Software: SimaPro rev. 8.0.2 (www.pre.nl)
Main database: Ecoinvent 2.2
Report LCA: Life Cycle Inventory of galvanized steel by European General Galvanizers Association for EPD® and LCI purposes - 07/09/2016 FINAL report
Geographical scope of the EPD: Europe

Environmental declarations published within the same product category, though originating from different programs, may not be comparable. In particular EPDs of construction products may not be comparable if they do not comply with EN 15804.

CONTACTS

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LIFE CYCLE ENGINEERING

EPD®
ENVIRONMENTAL PRODUCT DECLARATION

INDEPENDENT VERIFICATION

Product Category Rules (PCR) review was conducted by:
The Technical Committee of the International EPD® System. Chair: Massimo Marino. Contact via info@environdec.com

Independent verification of the declaration and data, according to EN ISO 14025 : 2010

☐ EPD process certification (Internal)

☑ EPD verification (External)

Third party verifier: *Ugo Pretato. Contact via pretato@studiofieschi.it*

Accredited by: *The International EPD® System*

Cover image: Werner-Von-Siemens-School, Bochum by Reiser + Partner Architects, Bochum, Winner German Galvanizers Award 2011 (Photo: Rainer Grünewald, Velbert)