Environmental Product Declaration

EPD Number: BREG EN EPD 000011 Issue: 02

This is to certify that this verified Environmental Product Declaration provided by:

UK CARES

Is in accordance with the requirements of:

EN 15804:2012+A1:2013

This declaration is for:

Carbon Steel Reinforcing Bar (secondary production route – scrap), Sector Average

Company Address

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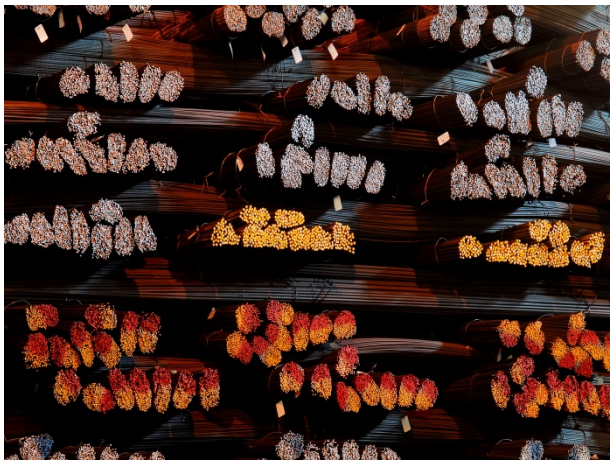

Signed for BRE Global Ltd	Derek Hughes Operator	31 July 2014 Date of this Issue
31 July 2014 Date of First Issue		30 July 2016 Expiry Date

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EPD verification and LCA details

Demonstration of Verification
CEN standard EN 15804 serves as the core PCR[a]
Independent verification of the declaration and data according to EN ISO 14025:2010 ☐ Internal ☑ External
Third party verifier[b]: **Kim Allbury**
a: Product category rules b: Optional for business-to-business communication; mandatory for business-to-consumer communication (see EN ISO 14025:2010, 9.4)

LCA Consultant	Verifier
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General Information

Summary

This environmental product declaration is for 1 tonne of Carbon Steel Reinforcing Bar (secondary production route – scrap), Sector Average produced by UK CARES at the following manufacturing facilities:

ALPA Gargenville Z.I. de Limay-Porcheville 25 avenue du Val 78440 Gargenville France	ArcelorMittal Hamburg GmbH Dradenaustrasse 33 Hamburg D21129 Germany	ArcelorMittal Rodange & Schifflange 2 rue de l'industrie BP 24 L4823 Rodange Luxembourg
ArcelorMittal Zaragoza S.A. Ctra Torrecilla de Valmadrid, Km 1.95 50720 La Cartuja Baja Zaragoza Spain	ArcelorMittal Gipuzkoa S.L.U Barrio Artiz 34 Zumarraga 20700 Spain	Diler Demir Celik Endustri ve Ticaret A.S. Dilovasi Organize Sanayi Bolgesi 1 Kisim Dilce Cad. No: 30 41455 – Dilovasi, Kocaeli Turkey
Ekinciler Iron & Steel Works Inc. Organize Sanayi Bolgesi PK 240 Sariseki 31240 – Iskenderun, Hatay Turkey	Habas A.S. Sanayi Caddesi No: 26 35800 Bozkoy - Aliaga Izmir Turkey	Icdas A.S. 17200 Biga Canakkale Turkey
Izmir Demir Celik Sanayi A.S. Nemrut Caddesi No. 2 Horozgedigi Koyu 35807 Aliaga, Izmir Turkey	Kroman Celik Sanayi A.S. Emek Mah. Asiroglu Cad. No: 155 41700 Darica, Kocaeli Turkey	Megasa Siderurgica S.L. Carretera de Castilla No.: 802-820 15570 Naron, A Coruna Spain
Nursan Celik Sanayi ve Haddecilik A.S. Organize Sanayi Bolgesi Sincan yolu uzeri Payas, Hatay Turkey	Nursan Metalurji Endustrisi A.S. Payas Organize Sanayi Bolgesi Sincan yolu uzeri Payas, Hatay Turkey	SN Maia – Siderurgica S.A. Fabrica de Maia 4425 S. Pedro de Fins Maia Portugal
SN Seixal – Siderurgica Nacional S.A. 2840-075 Aldeia de Paio Pires Portugal	Yazici Demir Celik San. Ve Turizm Tic. A.S. Organize Sanayi Bolgesi Sariseki, Iskenderun, Hatay Turkey	

This is a Cradle to gate with options EPD. The life cycle stages included are as shown below (X = included, MND = module not declared):

Product			Construction		Use stage							End-of-life					Benefits and loads beyond the system boundary
					Related to the building fabric					Related to the building							
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4		D
Raw materials supply	Transport	Manufacturing	Transport to site	Construction - Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy use	Operational Water use	Deconstruction demolition	Transport	Waste processing	Disposal		Reuse, Recovery and/or Recycling potential
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x

Programme Operator

BRE Global, Watford, Herts, WD25 9XX, United Kingdom.
This declaration is based on the BRE Environmental Profiles 2013 Product Category Rules for Type III environmental product declaration of construction products to EN 15804:2012+A1:2013.

Comparability

Environmental declarations from different programmes may not be comparable if not compliant with EN 15804:2012+A1:2013. Comparability is further dependent on the product category rules used and the source of the data, e.g. the database. See EN 15804:2012+A1:2013 for further guidance.

Construction Product:

Product Description

Reinforcing steel bar according to BS 4449, ASTM A615, ASTM A706, EN 10080, ISO 6935, DIN 488-2, NF A 35 080-1, CAN/CSA G30.18-09, UNE 36068, NBN A 24 – 301 & 304, SFS 1215, LNEC E450 & E460, NEN 6008, NS 3576-3, TS 708, SS 560, BDS 9252, AS/NZS 4671, MS 146, NBR 7480, SI 4466-3 and GOST R 52544 (reinforcing steel in bars and coils) that is obtained from scrap, melted in an Electric Arc Furnace (EAF) followed by hot rolling.

The declared unit is 1 tonne of carbon steel reinforcing bars as used within concrete structures for a commercial building.

Technical Information

Name	Value	Unit
Production route	EAF	
Density	7850	Kg/m^3
Modulus of elasticity	200000	N/mm^2
Shear modulus	77000	N/mm^2
Recycled content	97	%

Product Contents

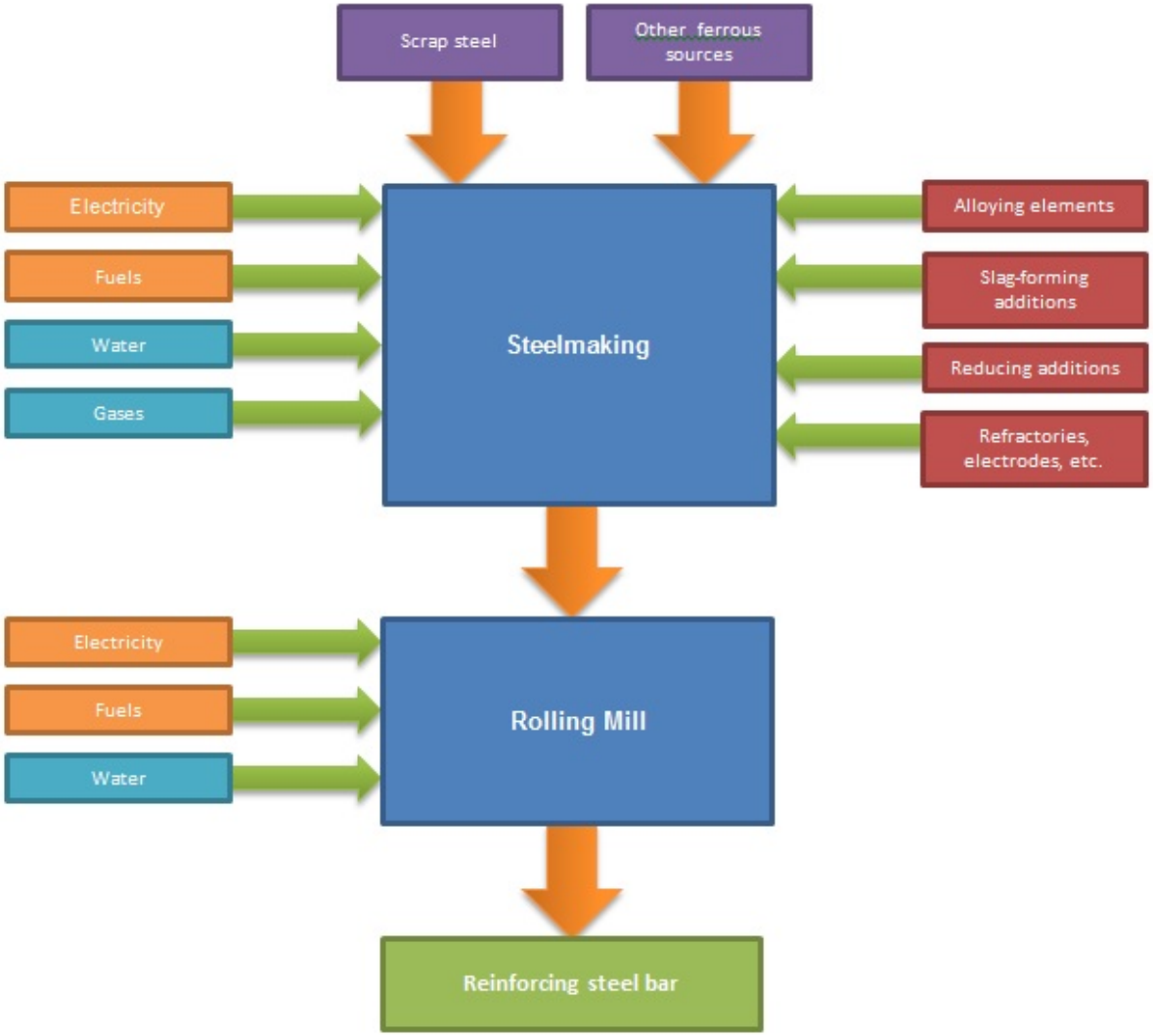
Material/Chemical Input	%
Fe	97
C, Mn, Si, V, Ni, Cu, Cr, Mo and others	3

Manufacturing Process

Scrap metal is melted in an electric arc furnace to obtain liquid steel. This is then refined to remove impurities and alloying additions can be added to give the required properties.

Hot metal (molten steel) from the EAF is then cast into steel billets before being sent to the rolling mill where they are rolled and shaped to the required dimensions for the finished bars and coils of reinforcing steel.

The process flow diagram is shown below:



Construction Installation

Processing and proper use of reinforcing steel products depends on the application and should be made in accordance with generally accepted practices, standards and manufacturing recommendations.

During transport and storage of reinforcing steel products the usual requirements for securing loads is to be observed.

Use Information

The composition of the reinforcing steel products does not change during use.
Reinforcing steel products do not cause adverse health effects under normal conditions of use.
No risks to the environment and living organisms are known to result from the mechanical destruction of the reinforcing steel bar product itself.

Reference Service Life

Reinforcing steel products are in the main building structure so the reference service life will equal the lifetime of the building.

End of Life

Reinforcing steel products are not reused at end of life but can be recycled to the same (or higher/lower) quality of steel depending upon the metallurgy and processing of the recycling route. It is a high value resource so efforts are made to recycle steel scrap rather than disposing of it at EoL. A recycling rate of 92% is typical for reinforcing steel bar products.

Disposal results in minimal environmental impacts due to the inert nature of the material.

Life Cycle Assessment Calculation Rules

Declared / Functional unit

The declared unit is 1 tonne of carbon steel reinforcing bars as used within concrete structures for a commercial building (i.e. 1 tonne in use, accounting for losses during fabrication and installation, not 1 tonne as produced).

System boundary

The system boundary of the EPD follows the modular design defined by EN 15804. This is a cradle to grave EPD and thus covers all modules from A1 to C4 and includes module D as well.
Impacts and aspects related to losses/wastage (i.e. production, transport and waste processing and end-of-life stage of lost waste products and materials) are considered in the modules in which the losses/wastage occur.

Data sources, quality and allocation

Data Sources: This is a Trade Association EPD, a declaration of an average product originating from several plants of several manufacturers. Production data has been supplied by 17 clients of UK CARES.

Data Quality: Background data are consistently sourced from PE databases. All these datasets are less than 5 years old. The primary data collection was thorough, considering all relevant mass and energy input and output flows and these data have been verified by UK CARES.

Allocation: EAF slag and mill scale are produced as a co-products from the steel manufacturing process; with mill scale also a by-product at the rolling mill. Impacts are allocated between the steel, the slag and the mill scale based on economic allocations.
Production losses of steel during the production process are recycled in a closed loop offsetting the requirement for external scrap.
Specific information on allocation within the background data is given in the GaBi datasets documentation (GaBi 6 2012).

Cut-off criteria

On the input side all flows entering the system and comprising more than 1% in total mass or contributing more than 1% to primary energy consumption are considered. All inputs used as well as all process-specific waste and process emissions were assessed. For this reason material streams which were below 1% (by mass) were captured as well. In this manner the cut-off criteria according to the BRE guidelines are fulfilled.

LCA Results

(INA = Indicator not assessed, AGG = Aggregated, NA = Not Applicable)

Indicator	Unit	A1	A2	A3	A1-A3	A4	A5	B1	B2	B3
		Raw materials supply	Transport to factory	Manufacturing	Aggregated	Transport to site	Construction - installation	Use	Maintenance	Repair
Environmental impacts per declared/functional unit										
GWP	kg CO_2 eq.	AGG	AGG	AGG	785	16.2	89	0	0	0
ODP	kg CFC 11 eq.	AGG	AGG	AGG	7.63E-07	7.76E-11	7.64E-08	0	0	0
AP	kg SO_2 eq.	AGG	AGG	AGG	3.53	0.0438	0.37	0	0	0
EP	kg $(PO_4)^{3-}$eq.	AGG	AGG	AGG	0.331	0.00898	0.0374	0	0	0
POCP	kg C_2H_4 eq.	AGG	AGG	AGG	0.254	-0.0111	0.021	0	0	0
ADPE	kg Sb eq.	AGG	AGG	AGG	0.000132	6.11E-07	1.98E-05	0	0	0
ADPF	MJ eq.	AGG	AGG	AGG	9350	224	1090	0	0	0
GWP = Global Warming Potential (Climate Change); ODP = Ozone Depletion Potential; AP = Acidification Potential for Soil and Water; EP =Eutrophication Potential; POCP = Photochemical Ozone Creation; ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential - Fossil Fuels										
Resource use										
PERE	MJ	AGG	AGG	AGG	1160	8.81	180	0	0	0
PERM	MJ	AGG	AGG	AGG	0	0	0	0	0	0
PERT	MJ	AGG	AGG	AGG	1160	8.81	180	0	0	0
PENRE	MJ	AGG	AGG	AGG	10400	224	1220	0	0	0
PENRM	MJ	AGG	AGG	AGG	0	0	0	0	0	0
PENRT	MJ	AGG	AGG	AGG	10400	224	1220	0	0	0
SM	kg	AGG	AGG	AGG	1150	0	115	0	0	0
RSF	MJ	AGG	AGG	AGG	-0.302	0.00144	0	0	0	0
NRSF	MJ	AGG	AGG	AGG	-3.48	0.0151	0	0	0	0
FW	m^3	AGG	AGG	AGG	0.995	0.00549	0.123	0	0	0
PERE = Use of renewable primary energy excluding renewable primary energy used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water										
Waste to disposal										
HWD	kg	AGG	AGG	AGG	0.969	0.000511	0.111	0	0	0
NHWD	kg	AGG	AGG	AGG	97	0.0282	19.5	0	0	0
TRWD	kg	AGG	AGG	AGG	0.404	0.000294	0.0489	0	0	0
RWDHL	kg	AGG	AGG	AGG	0.000496	4.19E-07	5.99E-05	0	0	0
HWD = Hazardous waste disposal NHWD = non-hazardous waste disposed; TRWD = Total Radioactive waste disposed; RWDHL = Radioactive waste disposed (high-level nuclear waste)										
Other output flows										
CRU	kg	AGG	AGG	AGG	0	0	0	0	0	0
MFR	kg	AGG	AGG	AGG	0	0	120	0	0	0
MER	kg	AGG	AGG	AGG	0	0	0	0	0	0
EE	MJ	AGG	AGG	AGG	0	0	0	0	0	0
CRU = Components for reuse; MFR = Materials for recycling; MER = Materials for energy recovery; EE = Export energy										

LCA Results (continued)

(INA = Indicator not assessed, AGG = Aggregated, NA = Not Applicable)

Indicator	Unit	B4 Replacement	B5 Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction demolition	C2 Transport	C3 Waste processing	C4 Disposal	D Reuse/ Recovery/ Recycling potential
Environmental impacts per declared/functional unit										
GWP	kg CO_2 eq.	0	0	0	0	2.04	39.1	0	1.08	401
ODP	kg CFC 11 eq.	0	0	0	0	8.08E-12	1.85E-10	0	1.47E-11	-2.79E-09
AP	kg SO_2 eq.	0	0	0	0	0.00435	0.136	0	0.00689	1.53
EP	kg $(PO_4)^{3-}$ eq.	0	0	0	0	0.000507	0.0294	0	0.000945	0.128
POCP	kg C_2H_4 eq.	0	0	0	0	0.000419	-0.0324	0	0.00066	0.231
ADPE	kg Sb eq.	0	0	0	0	5.98E-08	1.45E-06	0	4.08E-07	7.93E-06
ADPF	MJ eq.	0	0	0	0	28.4	539	0	14.2	3740
GWP = Global Warming Potential (Climate Change); ODP = Ozone Depletion Potential; AP = Acidification Potential for Soil and Water; EP =Eutrophication Potential; POCP = Photochemical Ozone Creation; ADPE = Abiotic Depletion Potential – Elements; ADPF = Abiotic Depletion Potential - Fossil Fuels										
Resource use										
PERE	MJ	0	0	0	0	0.051	20.2	0	1.23	-75
PERM	MJ	0	0	0	0	0	0	0	0	0
PERT	MJ	0	0	0	0	0.051	20.2	0	1.23	-75
PENRE	MJ	0	0	0	0	28.5	541	0	14.9	3500
PENRM	MJ	0	0	0	0	0	0	0	0	0
PENRT	MJ	0	0	0	0	28.5	541	0	14.9	3500
SM	kg	0	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0.000242	0.00346	0	0.0267	-4.93
NRSF	MJ	0	0	0	0	0.00254	0.0362	0	0.0576	-51.9
FW	m^3	0	0	0	0	0.000185	0.0127	0	-0.0501	0.193
PERE = Use of renewable primary energy excluding renewable primary energy used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Net use of fresh water										
Waste to disposal										
HWD	kg	0	0	0	0	3.20E-05	0.0012	0	0.000669	-0.276
NHWD	kg	0	0	0	0	0.00331	0.0646	0	80.1	5.74
TRWD	kg	0	0	0	0	3.42E-05	0.000704	0	0.00026	-0.095
RWDHL	kg	0	0	0	0	4.95E-08	1.01E-06	0	3.28E-07	-1.19E-04
HWD = Hazardous waste disposal NHWD = non-hazardous waste disposed; TRWD = Total Radioactive waste disposed; RWDHL = Radioactive waste disposed (high-level nuclear waste)										
Other output flows										
CRU	kg	0	0	0	0	0	0	0	0	0
MFR	kg	0	0	0	0	0	0	920	0	0
MER	kg	0	0	0	0	0	0	0	0	0
EE	MJ	0	0	0	0	0	0	0	0	0
CRU = Components for reuse; MFR = Materials for recycling; MER = Materials for energy recovery; EE = Export energy										

Scenarios and additional technical information

Module A4 – Transport to the building site				
Vehicle Type	**Fuel Consumption (L/km)**	**Distance (km)**	**Capacity Utilisation (%)**	**Density of Product (kg/m^3)**
Truck trailer	1.56	350	85	7850

Module A5 – Installation in the building			
Parameter	**Description**	**Unit**	**Value**
Ancilliary materials installation	Waste material from fabrication, losses per tonne of construction steel forms	%	2
Energy use	Energy per tonne required to fabricate construction steel forms from rebar	kWh	15.34
Waste materials from installation wastage	Waste material from installation	%	10

Module B2 – Maintenance			
Parameter	**Description**	**Unit**	**Value**
Maintenance process description or source of information	No maintenance required for rebar within concrete	-	-

Module B3– Repair			
Parameter	**Description**	**Unit**	**Value**
Repair process description or source of information	No repair process required for rebar within concrete	-	-

Module B4 – Replacement			
Parameter	**Description**	**Unit**	**Value**
Replacement cycle	No replacement considerations required for rebar within concrete	-	-

Module B5 – Refurbishment			
Parameter	**Description**	**Unit**	**Value**
Refurbishment process description or source of information	No refurbishment process required for rebar within concrete	-	-

Module B6 – Use of energy; and Module B7 – Use of water			
Parameter	**Description**	**Unit**	**Value**
Other assumptions for scenario development, e.g. frequency of use, number of occupants	No use phase requirements of either water or energy required for rebar within concrete	-	-

End-of-life modules – C1, C3, and C4			
Parameter	**Description**	**Unit**	**Value**
Waste for recycling	Recovered steel from crushed concrete	%	92

End-of-life modules – C1, C3, and C4			
Waste for energy recovery	Energy recovery is not considered for this study as most end of life steel scrap is recycled, while the remainder is landfilled	-	-
Waste for final disposal	Unrecoverable steel lost in crushed concrete and sent to landfill	%	8
Other assumptions for scenario development, e.g. transportation	Portion of energy assigned to rebar from energy required to demolish building, per tonne	MJ	24

Module C2 – Transport to waste processing				
Vehicle Type	**Fuel Consumption (L/km)**	**Distance (km)**	**Capacity Utilisation (%)**	**Density of Product (kg/m^3)**
Truck	1.56	463	85	7850
Container ship	0.00401	158	50	7850

Module D – Reuse/Recovery/Recycling potential
It is assumed that 92% of rebar is recoverable & available for benefits beyond the system boundary. In the secondary production route, more scrap is required as input to the system than is recovered at end of life (there is also approx. 5% yield loss during the recycling process itself such that 1.05 tonne scrap input is required/tonne product manufactured). The net effect of this is that module D mainly models the burdens associated with the scrap input to the steelmaking process.

Interpretation

The results presented in this EPD are an average of 17 sites which produce rebar. There is quite a degree of variability in the individual results across the participating sites. For this reason, the life cycle interpretation given in this section will be kept at a relatively high level and presented in terms of the general trends observed in the individual site results.

Global Warming Potential (GWP)
The majority of the lifecycle GWP impact occurs in the production phase (A1-A3). The most significant contributions to production phase impacts are: the upstream production of raw materials used in the steelmaking process, generation/supply of electricity and the production/use of fuels on site. Fabrication, installation and the end-of-life processes covered in C1-C4 make a minimal contribution to GWP. Scrap burdens reported in module D have a significant contribution.

Ozone Depletion Potential (ODP)
The majority of impacts are associated with the production phase (A1-A3). Significant contributions to production phase impact come from the emission of ozone depleting substances during the upstream production of raw materials/pre-products as well as those arising from electricity production. Module D shows a very small credit even though scrap burdens are being assessed in this phase. This is explained because ODP emissions are linked to grid electricity production used in secondary production.

Acidification Potential (AP)
The majority of the lifecycle AP impact occurs in the production phase (A1-A3), similar to GWP. The major contributors to production phase AP impacts comes from energy resources used in the production of the raw materials and pre-products for the steelmaking process and from transportation.

Fabrication, installation and the end-of-life processes classed under C1-C4 make minimal contributions.
As with GWP, scrap burdens reported in module D have a significant contribution.

Eutrophication Potential (EP)
The major eutrophication impacts occur in the production phase (A1-A3). Significant contributions to production phase impact comes from the production of raw materials and transport. Fabrication, installation and the end-of-life processes classed under C1-C4 again make minimal contributions.
As with GWP, scrap burdens reported in module D have a significant contribution.

Photochemical Ozone Creation Potential (POCP)
The production phase is the dominant phase of the lifecycle with regards to POCP impacts. Again, these are all emissions commonly associated with the combustion of fuels. Significant contributors to POCP are the upstream production of raw materials/pre-products and transport, directly linked to fossil fuel combustion. It should be noted that the impacts for steel recycling in module D is almost of the same magnitude as the production phase impacts.

Primary Energy Demand - Non-renewable (PENRT)
In terms of lifecycle phases, PENRT exhibits the same trends as other categories driven by the combustion of fossil fuels and other non-renewable fuel sources. A1-A3 is the most significant contributor to life cycle impacts for PENRT. Significant contributions here come from the energy resources used in the production of the raw materials and pre-products for the steelmaking process, from non-renewable resource consumption for electricity generation/supply and the upstream production of fuels used on site.
As for GWP, scrap burdens reported in module D have a significant contribution.

Primary Energy Demand – Renewable (PERT)
Majority of the energy consumption takes place during the production phase, A1-A3. However, unlike other categories, the largest contributor to PERT impacts here comes from the consumption of renewable energy resources required for the generation/supply of electricity. It should be noted that PERT generally only represents a small percentage of the production phase primary energy demand with the bulk of the demand coming from non-renewable energy resources.
The credit observed in module D can be explained by the different energy mixes used for primary and secondary steel production.

Abiotic Depletion Potential (Elements)
The largest contribution to $ADP_{elements}$ over the entire life cycle is the production phase, A1-A3. The majority of the impacts are from the production of raw materials, in particular the consumption of iron related products.

Abiotic Depletion Potential (Fossil)
The largest contribution to $ADP_{fossils}$ over the entire life cycle is the production phase, A1-A3. The general trend from the individual site results is very similar to that described in description of PENRT above.

	GWP	ODP	AP	EP	POCP	ADPE	ADPF
A1-A3	84.2%	90.9%	86.2%	81.1%	109.2%	85.5%	83.1%
A4	1.7%	0.0%	1.1%	2.2%	-4.8%	0.4%	2.0%
A5	9.6%	9.1%	9.1%	9.2%	9.0%	12.9%	9.7%
C1	0.2%	0.0%	0.1%	0.1%	0.2%	0.0%	0.3%
C2	4.2%	0.0%	3.3%	7.2%	-13.9%	0.9%	4.8%
C4	0.1%	0.0%	0.2%	0.2%	0.3%	0.3%	0.1%

Mean contributions to selected environmental indicators by life cycle stage

Environmental impact results for total life cycle showing standard deviation

RESULTS OF THE LCA – ENVIRONMENTAL IMPACT & PRIMARY ENERGY DEMAND			
Parameter	**Unit**	**Mean life cycle value**	**Standard Deviation**
GWP	kg CO_2-Eq.	1330	235
ODP	kg CFC11-Eq.	8.37E-07	6.07E-07
AP	kg SO_2-Eq.	5.63	1.47
EP	kg PO_4^{3-}- Eq.	0.536	0.146
POCP	kg C_2H_4 Eq.	0.463	0.094
ADPE	kg Sb Eq.	1.62E-04	6.15E-05
ADPF	MJ	15000	2630
PERT	MJ	1290	580
PENRT	MJ	15900	2300

Sources of additional information

BRE Global. BRE Environmental Profiles 2013 Product Category Rules for Type III environmental product declaration of construction products to EN 15804:2012+A1:2013. PN 514. Watford, BRE, 2014.

BSI. Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. BS EN 15804:2012+A1:2013. London, BSI, 2013.

BSI. Environmental labels and declarations – Type III Environmental declarations – Principles and procedures. BS EN ISO 14025:2010 (exactly identical to ISO 14025:2006). London, BSI, 2010.

BSI. Environmental management – Life cycle assessment – Principles and framework. BS EN ISO 14040:2006. London, BSI, 2006.

BSI. Environmental management – Life cycle assessment – requirements and guidelines. BS EN ISO 14044:2006. London, BSI, 2006.

Demolition Energy Analysis of Office Building Structural Systems, Athena Sustainable Materials Institute, 1997.

PE INTERNATIONAL AG; GaBi 6: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 1992-2013.

GaBi 6: Documentation of GaBi 6: Software-System and Database for Life Cycle Engineering. Copyright, TM. Stuttgart, Echterdingen, 1992-2013. http://documentation.gabi-software.com/

International Energy Agency, Energy Statistics 2013. http://www.iea.org

Kreißig, J. und J. Kuemmel (1999): Baustoff-Oekobilanzen. Wirkungsabschaftzung und Auswertung in der Steine-Erden-Industrie. Hrsg. Bundesverband Baustoffe Steine + Erden e.V.

London Metal Exchange, Steel Billet Prices, March 2014. https://www.lme.com/metals/steel-billet/

U.S. Geological Survey, Mineral Commodity Summaries, Iron and Steel Slag, January 2006

Sustainability of construction works – Environmental product declarations – Methodology for selection and use of generic data; German version CEN/TR 15941

REGULATION (EU) No 305/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC.

CARES SCS Sustainable Constructional Steel Scheme. Appendix 1 – Operational assessment schedule for the sustainable production of carbon steel bars for the reinforcement of concrete.

CARES SRC Steel for the Reinforcement of Concrete Scheme. Appendix 1 – Quality and operations assessment schedule for carbon steel bars for the reinforcement of concrete including inspection and testing requirements.

BS 4449:2005+A2:2009 Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification.

BS 4449:1997+A1 Carbon Steel Bars for the reinforcement of concrete – Specification.

ASTM A615/A615M – 14 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

ASTM A706/A706M – 14 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

EN 10080:2005 Steel for the reinforcement of concrete. Weldable reinforcing steel. General

ISO 6935-2:2007 - Steel for the reinforcement of concrete - Part 2: Ribbed bars.

DIN 488-2:2009 - Reinforcing steels - Reinforcing steel bars.

NF A35-080-1 Décembre 2013 - Aciers pour béton armé - Aciers soudables - Partie 1 : barres et couronnes.

CAN/CSA G30.18-09:2009 Carbon steel bars for concrete reinforcement.

UNE 36068:2011 - Ribbed bars of weldable steel for the reinforcement of concrete.

NBN A 24-301&304:1986 - Steel for reinforcement.

SFS 1215:1996 - Reinforcing steels. Weldable hot rolled ribbed steel bars A500HW.

LNEC E450&E460:2010 - Ribbed bars of weldable steel for the reinforcement of concrete.

NEN 6008:2008 nl - Steel for the reinforcement of concrete.

NS 3576-3:2012 - Steel for the reinforcement of concrete - Dimensions and properties - Part 3: Ribbed steel B500NC.

TS 708:2010 - Steel for the reinforcement of concrete - Reinforcing steel.

SS 560:2010 - Steel for the reinforcement of concrete – Weldable reinforcing steel – Bar, coil and decoiled product.

BDS 9252:2007 - Steel for the reinforcement of concrete - Weldable reinforcing steel B500.

AS/NZS 4671:2001 - Steel reinforcing materials.

MS 146:2006 - Hot rolled steel bars for the reinforcement of concrete – Specification.

NBR 7480:2007 - Steel For The Reinforcement Of Concrete Structures – Specification.

SI 4466-3:2013 - Steel for the reinforcement of concrete: Ribbed Bars.

GOST R 52544:2006 - Weldable deformed reinforcing rolled products of A500C and B500C classes for reinforcement of concrete constructions. Specifications.