TATA STEEL

TATA

Structural hollow sections

Environmental Product Declaration

CONTENTS

Structural hollow sections
Environmental Product Declaration
(in accordance with EN 15804 and ISO 14025)

This EPD is representative and valid for the specified (named) product

Declaration number: EPD-TS-2017-003
Date of issue: 31st May 2017
Valid until: 1st June 2022

Owner of the Declaration: Tata Steel Europe
Programme Operator: Tata Steel UK Limited, 30 Millbank, London, SW1P 4WY

The CEN standard EN 15804:2012+A1:2013 serves as the core Product Category Rules (PCR) supported by Tata Steel's EN 15804 verified EPD PCR documents
Independent verification of the declaration and data, according to EN ISO 14025:2010

Internal ☐ External ☒

Author of the Life Cycle Assessment: Tata Steel UK
Third party verifier: Olivier Muller, PricewaterhouseCoopers, Paris

1 General information

Owner of EPD	Tata Steel UK
Product	Structural hollow sections
Manufacturer	Tata Steel Europe
Manufacturing sites	Port Talbot, Corby and Hartlepool (UK) and Maastricht, Zwijndrecht and IJmuiden (Netherlands)
Product applications	Construction and infrastructure, lifting and excavating equipment, offshore structures, mechanical related applications such as wind bracing and machinery
Declared unit	1 tonne of steel product
Date of issue	31st May 2017
Valid until	1st June 2022

This environmental product declaration is for all structural hollow steel sections manufactured by Tata Steel in the UK and Netherlands. The environmental indicators are average values for hot finished and cold formed tube products from Corby, Hartlepool, Maastricht and Zwijndrecht, with feedstock supplied from Port Talbot and IJmuiden.

The information in the environmental product declaration is based on production data from 2012, 2013 and 2014.

EN 15804 serves as the core PCR, supported by Tata Steel's EN 15804 verified EPD programme Product Category Rules documents, and this declaration has been independently verified according to ISO 14025[1,2,3,4,5,6,7].

Third party verifier

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2 Product information

2.1 Product Description

Hybox® cold formed and Celsius® hot finished structural hollow sections (sometimes referred to as 'tubes'), are manufactured in a range of circular, square, rectangular and elliptical shaped tubes. They are manufactured to standard grades in a range of sizes from 21.3 to 508mm, with wall thicknesses from 2 to 16mm. The full range of Tata Steel's structural hollow sections are included in this EPD.

Cold formed tubes are made from fully killed steel, which is critical to formability and weldability, and the dimensions and corner radii are controlled to tight tolerances. They are strong, light, cost-effective and aesthetically appealing structural steel hollow sections that provide reliable formability and toughness. They can be used in a wide range of structural and engineering applications, including those where specific properties and compliance with design codes are required, and are suitable for galvanising.

Hot finished structural hollow sections are manufactured from normalised fine grain steel and combine high yield strength with lower carbon content for improved weldability and fabrication. Their applications include large-scale construction and building projects where the product's strength and weldability is suitable for both internal and external structural use, including multi-storey columns, space frames, and lattice beams. The sections can also be used in the offshore industry for both primary and secondary applications, and for industrial and 'off-highway' vehicles, such as cranes, excavators, bulldozers and dumper trucks.

2.2 Manufacturing

The manufacturing sites included in the EPD are listed in Table 1 below.

Table 1 Participating sites

Site name	Product	Country
Port Talbot	Hot rolled coil	UK
Corby	Structural hollow sections	UK
Hartlepool (20" Mill)	Structural hollow sections	UK
IJmuiden	Hot rolled coil	NL
Maastricht	Structural hollow sections	NL
Zwijndrecht	Structural hollow sections	NL

The process of hollow section manufacture at Tata Steel begins with sinter being produced from iron ore and limestone, and together with coke from coal, reduced in a blast furnace to produce iron. Steel scrap is then added to the liquid iron and oxygen is blown through the mixture to convert it into liquid steel in the basic oxygen furnace. The liquid steel is continuously cast into discrete slabs, which are subsequently reheated and rolled in a hot strip mill to produce steel coil, the primary feedstock of the hollow section manufacturing process. The hot rolled coils are transported by rail, from Port Talbot to either the Corby or Hartlepool tube manufacturing sites, and by inland waterway, from IJmuiden to either Maastricht or Zwijndrecht. An overview of the process from raw materials to hot rolled coil is shown in Figure 1.

The tube making process begins with the uncoiling, levelling, and slitting (except Hartlepool) of the hot rolled coil, which is then passed through a series of shaped rolls that gradually form the flat strip into a circular hollow section. The two strip edges, now adjacent to one another, are welded using a high frequency induction process. A further set of rolls effect the final shaping and sizing operation of the cold formed hollow section, and after trimming of the external weld bead and non-destructive testing, the tubes are cut to length prior to despatch or hot finishing. An overview of the process from hot rolled coil to cold formed structural hollow section is shown in Figure 2.

Figure 1 Process overview from raw materials to hot rolled coil

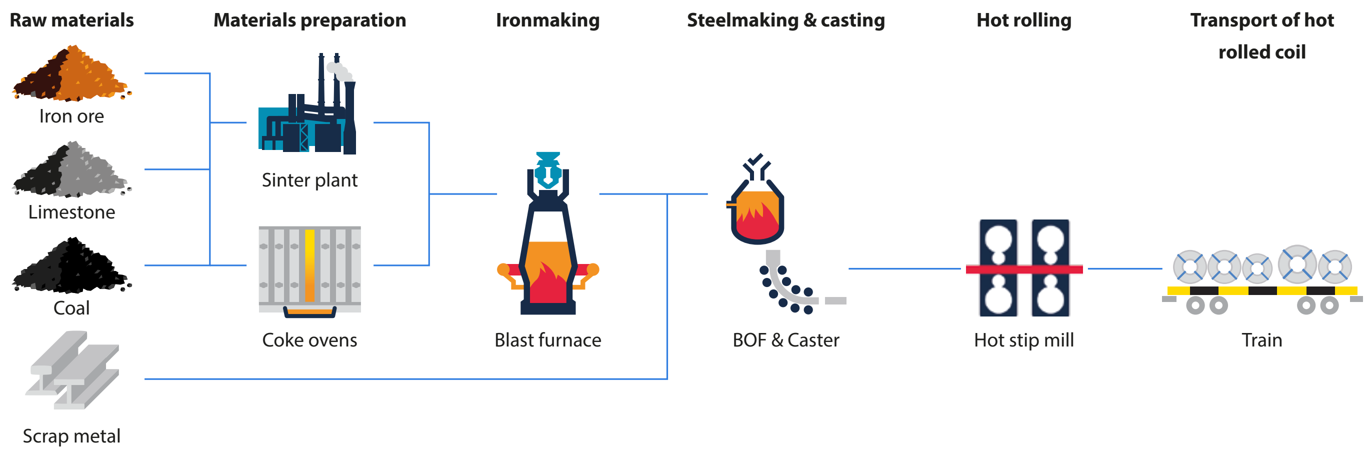


Figure 2 Process overview from hot rolled coil to cold formed hollow section

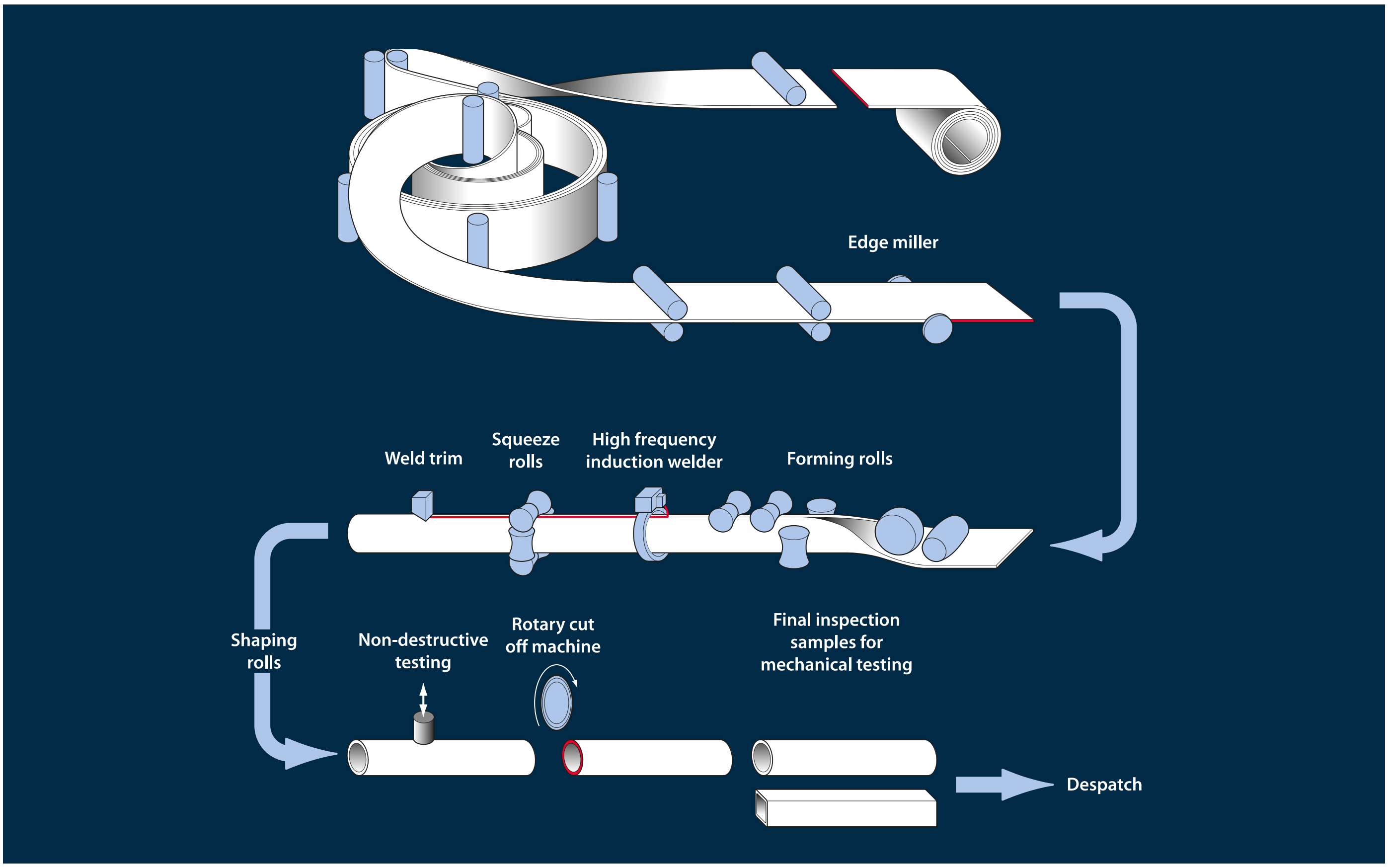
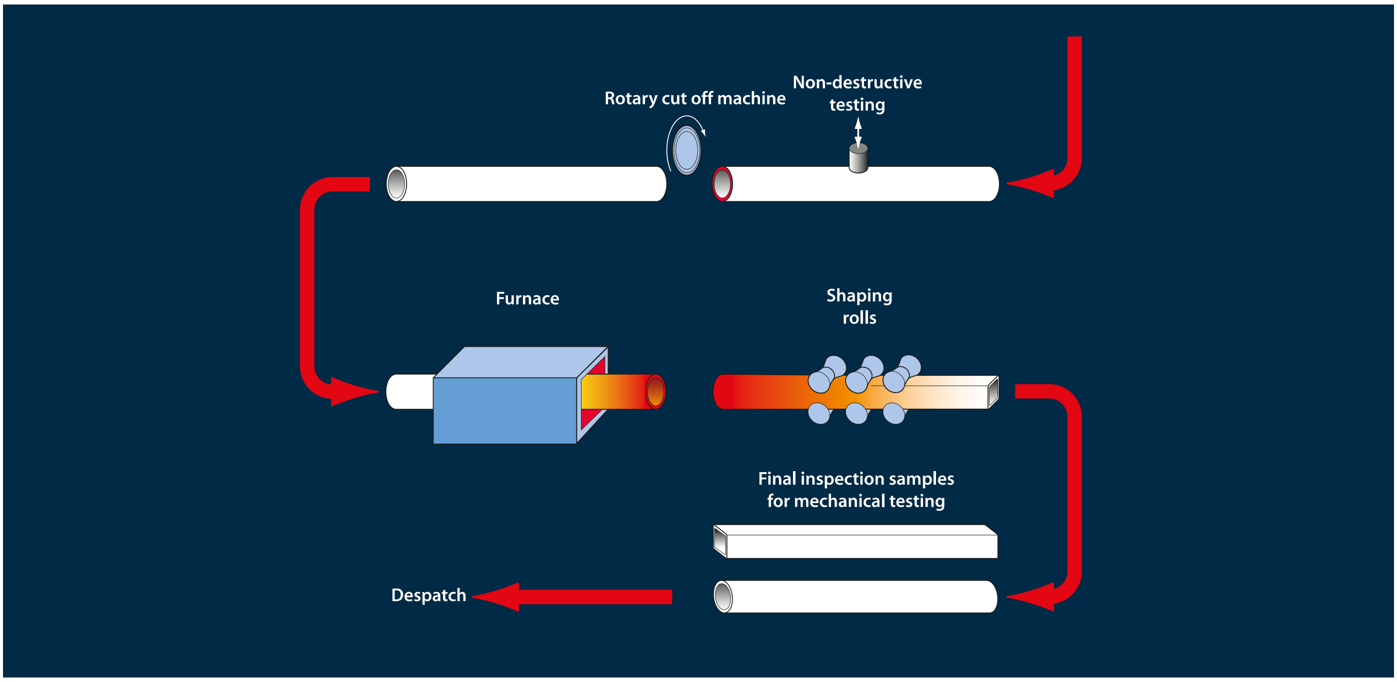


Figure 3 Hot finishing of cold formed hollow sections



The subsequent hot finishing process comprises a reheating operation, and with the section at a normalising temperature of approximately 900ºC, a further shaping and sizing operation imparts the product's final dimensions and properties. This process is shown in Figure 3 from the non-destructive testing stage onwards.

Process data for the manufacture of hot rolled coil at Port Talbot and IJmuiden was gathered as part of the latest worldsteel data collection. For both Port Talbot and IJmuiden, and for the tube making sites, the data collection was not only organised by site, but also by each process line within each site. In this way it was possible to attribute resource use and emissions to each process line, and using processed tonnage data for that line, also attribute resources and emissions to specific products.

2.3 Technical data and specifications

The general properties of structural hollow sections are shown in Table 2, and the technical specifications of both cold formed and hot finished structural hollow sections are presented in Table 3. The relevant European standard for cold formed structural hollow sections is EN 10219[8]. The relevant European standard for hot finished structural hollow sections is EN 10210, and there are additional standards for weldable structural steels for specific applications[9,10,11].

2.4 Packaging

Structural hollow sections are not normally painted or galvanised at the tube manufacturing sites as this is usually carried out after fabrication, and prior to this, the sections would be pickled or blast cleaned. Therefore the normal despatch from the tube mills merely consists of sheeting the load or enclosing in covered trailers. However, the coils will be securely banded prior to despatch from Port Talbot or IJmuiden to ensure a safe transit, and the tube products (in Corby sizes only) may also be bundled using steel banding. The coil banding is collected for recycling at the tube manufacturing sites as part of the process scrap, and any tube bundling bands are capable of being collected for recycling from our customers' sites.

2.5 Reference service life

A reference service life for structural hollow sections is not declared because they can be used in a variety of different forms of construction, and the final construction application is not defined. To determine the full service life of structural hollow sections, all factors would need to be included such as location and environment, corrosion protection, and fire protection. Corrosion and fire protection are usually applied during installation on site. Under 'normal' conditions, structural hollow sections would not need to be replaced over the life of the building or structure.

Structural hollow steel sections can be recovered and re-used or recycled repeatedly without loss of quality as a building material and they comply with the requirements of construction product class A1 (non-combustible). Tata Steel's structural hollow sections are supplied with full certification, declaration of performance (DoP) & factory production control (FPC) ensuring full traceability during and after the original service life.

Table 2 General properties of structural hollow sections

	Structural hollow sections
Density (kg/m^3)	7850
Modulus of Elasticity (N/mm^2)	210000
Coefficient of Thermal Expansion (10^{-6} K^{-1})	12
Thermal Conductivity (W/mK)	48
Melting Point (ºC)	1536
Electrical Conductivity at 20ºC (Ω^{-1} m^{-1})	3.9

Table 3 Technical specification of structural hollow sections

	Cold formed structural hollow sections
Specification	EN 10219 S355 J2H
Yield strength (min)	355N/mm^2
Tensile strength	470 to 630N/mm^2
Elongation (min)	20%
Impact strength	27 J at -20ºC
Carbon equivalent (max)	0.45
Certification	3.1 certification with Declaration of Performance and Factory Production Control for full traceability

	Hot finished structural hollow sections
Specification	EN 10210 S355NH
Yield strength (min)	355N/mm^2
Tensile strength	470 to 630N/mm^2
Elongation (min)	22%
Impact strength	40 J at -20ºC
Carbon equivalent (max)	0.43
Certification	3.1 certification with Declaration of Performance and Factory Production Control for full traceability

3 Life Cycle Assessment (LCA) methodology

3.1 Declared unit

The unit being declared is 1 tonne of steel structural hollow section.

3.2 Scope

This EPD can be regarded as cradle-to-gate (with options) and the modules considered in the LCA are;

A1-3: Product stage (raw material supply, transport to production site, manufacturing)
C2 & C4: end-of-life (transport and disposal)
D: Reuse, recycling and recovery

The life cycle stages are explained in more detail in Figure 4.

3.3 Cut-off criteria

All information from the data collection process has been considered, covering all used and registered materials, and all fuel and energy consumption. On-site emissions were measured and those emissions have been considered. Data for all relevant sites were thoroughly checked and also cross-checked with one another to identify potential data gaps. No processes, materials or emissions that are known to make a significant contribution to the environmental impact of structural hollow sections have been omitted. On this basis, there is no evidence to suggest that input or outputs contributing more than 1% to the overall mass or energy of the system, or that are environmentally significant, have been omitted. It is estimated that the sum of any excluded flows contribute less than 5% to the impact assessment categories. The manufacturing of required machinery and other infrastructure is not considered in the LCA.

3.4 Background data

For life cycle modelling of the structural hollow sections, the GaBi Software System for life cycle engineering is used[12]. The GaBi database contains consistent and documented datasets which can viewed in the online GaBi documentation[13]. To ensure comparability of results in the LCA, the basic data of the GaBi database were used for energy, transportation and auxiliary materials. However, specific data derived from Tata Steel's own production processes were the first choice to use where available.

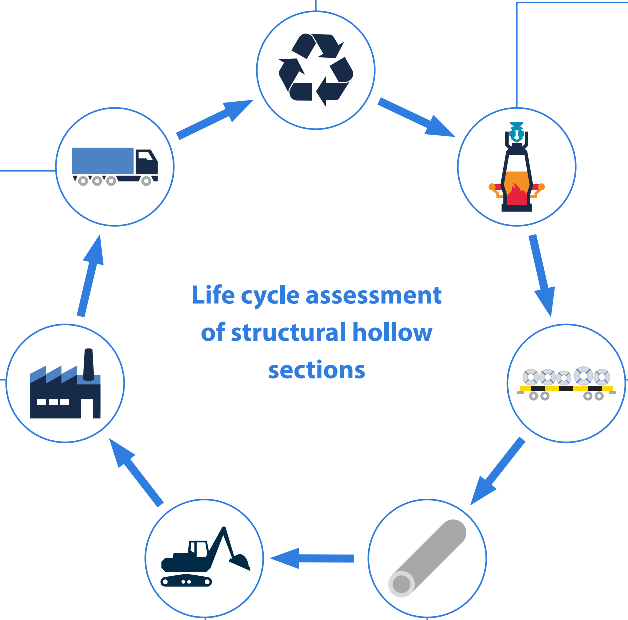
Figure 4 Life cycle assessment of structural hollow sections

Module D: Benefits & loads beyond the system boundary
Includes impacts from:
- Re-use (7%) and recycling (92%) of structural hollow section product

Module C: End of Life stage
Includes impacts from:
- Deconstructions or demolition
- Transport from site to End-of-Life
- Waste process for re-use or recycling (99%)
- Disposal to landfill (1%)

Module B: Use stage
Includes impacts from:
- Use or application of the steel component
- Maintenance, repair, replacement, refurbishment of the component

Module A4 & A5: Construction process stage
Includes impacts from:
- Transport to the building site and installation in to the building



Module A1: Product stage (primary processing)
Includes impacts from:
- Raw material extraction and processing (iron ore, coal)
- Steelmaking, casting and production of hot rolled coil at Port Talbot and IJmuiden
- Preparation of recycled scrap
- Responsible sourcing of materials

Module A2: Production stage (transport)
Includes impacts from:
- Transport of hot rolled coil from Port Talbot and Ijmuiden to tube manufacturing sites at Hartlepool, Corby, Maastricht and Zwijndrecht

Module A3: Product stage (Secondary processing)
Includes impacts from:
- Manufacture of structural hollow sections at Tata Steel sites in the UK (Corby and Hartlepool) and the Netherlands (Maastricht and Zwijndrecht)

3.5 Data quality

All relevant background datasets are taken from the GaBi 6 software database, and the last revision of these data sets took place less than 5 years ago. The data from Tata Steel's own production processes are from 2012, 2013 and 2014, and the technologies on which these processes were based during that period, are those used at the date of publication of this EPD. Therefore, the study is considered to be based on high quality data.

3.6 Allocation

To align with the requirements of EN 15804, a methodology is applied to assign impacts to the production of slag and hot metal from the blast furnace (co-products from steel manufacture), that was developed by the World Steel Association and EUROFER[14]. This methodology is based on physical and chemical partitioning of the manufacturing process, and therefore avoids the need to use allocation methods, which are based on relationships such as mass or economic value. It takes account of the manner in which changes in inputs and outputs affect the production of co-products and also takes account of material flows that carry specific inherent properties. This method is deemed to provide the most representative method to account for the production of blast furnace slag as a co-product.

Economic allocation was considered, as slag is designated as a low value co-product under EN 15804. However, as neither hot metal nor slag are tradable products upon leaving the blast furnace, economic allocation would most likely be based on estimates. Similarly BOF slag must undergo processing before being used as a clinker or cement substitute. The World Steel Association and EUROFER also highlight that companies purchasing and processing slag work on long term contracts which do not follow regular market dynamics of supply and demand.

Process gases arise from the production of the continuously cast steel slabs at Port Talbot and IJmuiden, and are accounted for using the system expansion method. This method is also referenced in the same EUROFER document and the impacts of co-product allocation, during manufacture, are accounted for in the product stage (Modules A1 to A3).

End of life assumptions for recovered steel and steel recycling are accounted for as per the current methodology from the World Steel Association 2017 Life Cycle Assessment methodology report[15]. A net scrap approach is used to avoid double accounting, and the net impacts are reported as benefits and loads beyond the system boundary (Module D).

3.7 Additional technical information

The main scenario assumptions used in the LCA are detailed below in Table 4. The end of life percentages are taken from a Tata Steel/ EUROFER recycling and re-use survey of UK demolition contractors carried out in 2014[16].

The environmental impacts presented in the 'LCA Results' section (4) are expressed with the impact category parameters of Life Cycle Impact Assessment (LCIA) using characterisation factors. The LCIA method used is CML 2001-April 2013[17].

3.8 Comparability

Care must be taken when comparing different EPDs. EPDs may not be comparable if they do not have the same functional unit or scope (for example, whether they include installation allowances in the building), or if they do not follow the same standard such as EN 15804. The use of different generic data sets for upstream or downstream processes that form part of the product system may also mean that EPDs are not comparable.

Comparisons should ideally be integrated into a whole building assessment, in order to capture any differences in other aspects of the building design that may result from specifying different products. For example, a higher strength product may require less material for the same function.

Table 4 Main scenario assumptions

Module	Scenario assumptions
A1 to A3 – Product stage	Actual manufacturing data is used from Tata Steel sites at Port Talbot, Corby, and Hartlepool (UK), and IJmuiden, Maastricht and Zwijndrecht (Netherlands)
A2 - Transport between Tata Steel sites	In the UK, typically 600km total transport distance (300km each way) on a 726t load capacity diesel train, 50% utilisation to account for empty returns, and in the Netherlands, typically 724km total transport distance (362km each way) on a 1500t load capacity barge, 42.5% utilisation to account for empty returns
C2 – Transport for recycling, re-use, and disposal	298km total transport distance (149km each way) on a 27t load capacity articulated lorry with 85% utilisation
C4 - Disposal	At end of life, 1% of product is disposed to landfill
D – Re-use, recycling, energy recovery	At end of life, 92% of product is recycled and 7% is re-used

4 Results of the LCA

Description of the system boundary

Product Stage			Construction Stage		Use Stage							End of Life Stage				Benefits and Loads Beyond the System Boundary
Raw material supply	Transport	Manufacturing	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse Recovery Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	MND	X	X

X = Included in LCA; MND = module not declared

Environmental impact:

1 tonne of structural hollow section

Parameter	Unit	A1 – A3	C2	C4	D
GWP	[kg CO_2 eq]	2500	13.8	0.161	-1530
ODP	[kg CFC11 eq]	3.81E-09	7.04E-12	1.63E-13	7.59E-06
AP	[kg SO_2 eq]	5.59	5.76E-02	9.55E-04	-3.06
EP	[kg PO_4^{3-} eq]	0.537	1.44E-02	1.30E-04	-0.237
POCP	[kg Ethene eq]	0.869	-2.34E-02	7.63E-05	-0.689
ADPE	[kg Sb eq]	2.63E-04	8.45E-07	5.78E-08	-3.90E-03
ADPF	[MJ]	25100	191	2.09	-14700

GWP = Global warming potential
ODP = Depletion potential of stratospheric ozone layer
AP = Acidification potential of land & water
EP = Eutrophication potential

POCP = Formation potential of tropospheric ozone photochemical oxidants
ADPE = Abiotic depletion potential for non-fossil resources
ADPF = Abiotic depletion potential for fossil resources

Resource use:

1 tonne of structural hollow section

Parameter	Unit	A1 – A3	C2	C4	D
PERE	[MJ]	545	9.05	0.252	837
PERM	[MJ]	0.0	0.0	0.0	0.0
PERT	[MJ]	545	9.05	0.252	837
PENRE	[MJ]	25500	192	2.16	-14300
PENRM	[MJ]	0.0	0.0	0.0	0.0
PENRT	[MJ]	25500	192	2.16	-14300
SM	[kg]	79.3	0.0	0.0	911
RSF	[MJ]	2.54E-02	0.0	0.0	-8.19E-03
NRSF	[MJ]	0.245	0.0	0.0	-6.78E-02
FW	[m^3]	1.13	0.205	1.07E-02	-7.98

PERE = Use of renewable primary energy excluding renewable primary energy resources 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 = Use of net fresh water

Output flows and waste categories:

1 tonne of structural hollow section

Parameter	Unit	A1 – A3	C2	C4	D
HWD	[kg]	8.37	0.0	0.0	-0.586
NHWD	[kg]	147	0.0	10.0	-10.3
RWD	[kg]	0.154	2.62E-04	2.95E-05	-1.03E-02
CRU	[kg]	0.0	0.0	0.0	0.0
MFR	[kg]	0.0	0.0	0.0	0.0
MER	[kg]	0.0	0.0	0.0	0.0
EEE	[MJ]	0.0	0.0	0.0	0.0
EET	[MJ]	0.0	0.0	0.0	0.0

HWD = Hazardous waste disposed

NHWD = Non-hazardous waste disposed

RWD = Radioactive waste disposed

CRU = Components for re-use

MFR = Materials for recycling

MER = Materials for energy recovery

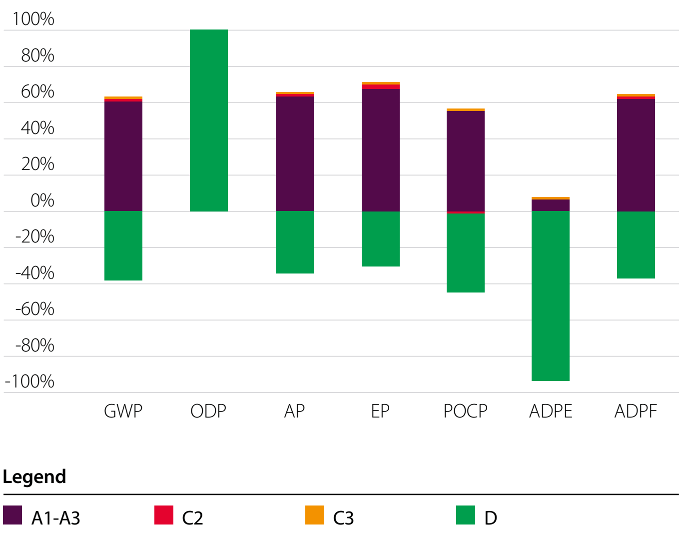
EEE = Exported electrical energy

EET = Exported thermal energy

5 Interpretation of results

Figure 5 shows the relative contribution per life cycle stage for each of the seven environmental impact categories. The main contributors across most impact categories are A1-A3 (burdens) and D (benefits beyond the system boundary). The manufacture of hot rolled coil is responsible for over 90% of each impact in A1-A3, specifically, the conversion of iron ore into liquid steel which is the most energy intensive part of the tube manufacturing process. These primary site emissions come from the use of coal and coke in the blast and basic oxygen furnaces as well as combustion of the process gases, which in total, give rise to more than 90% of the total emissions to air (CO_2, CO, and oxides of both sulphur and nitrogen).

Figure 5 LCA results for structural hollow sections



Module D values are derived using worldsteel's value of scrap methodology which is based upon many steel plants worldwide, including both BF/BOF and EAF steel production routes. At end-of-life, the recovered steel tubes are modelled with a credit given as if they were re-melted in an electric arc furnace and substituted by the same amount of steel produced in a blast furnace[15]. This usually results in a benefit, but the Module D impact for the ODP indicator is a positive value and does not contribute a reduction to the total. In other words, for ODP, the recycling impact is larger than the impact of primary manufacture, and this burden comes from the modelling of the scrap credit.

For the ADPE indicator, the benefit in Module D is much greater than the impact from manufacturing in A1-A3 and this results from the worldsteel 'value of scrap' calculation being based on many steel plants worldwide. In the case of ADPE, the Module D benefit is greater than the tube manufacturing burden because the Port Talbot and IJmuiden liquid steel production processes are more efficient than the average (the Module D benefit being a reflection of the world-wide steel plant average).

For use of net fresh water, Module D is a benefit, but the magnitude of this benefit is much greater than the impact from Modules A1-A3. Once again, this is a result of the way Module D is calculated. Both Port Talbot and IJmuiden, the biggest water users of the sites in this study, are relatively modest users of fresh water, and the worldwide average calculation for Module D includes many sites with considerably greater fresh water use in A1-A3 than either Port Talbot or IJmuiden.

There is limited variation of environmental impacts between the manufacture of both hot finished and cold formed products from the different tube manufacturing sites. This is highlighted in Table 5, which shows that the variations are all within 30% of the declared values except POCP. Also, the fact that more than 90% of the environmental impacts in A1-A3 are generated by production of the hot rolled coil, means that these impacts are independent of the size and shape of the subsequent manufactured tubes. The differences are therefore largely due to the production of hot rolled coil at either IJmuiden or Port Talbot.

Table 5 Variation in A1-A3 impact by tube manufacturing site

	A1-A3 Declared value	Maximum difference from declared value (by site) (%)
Global Warming Potential (GWP) [kg CO_2 eq]	2500	9.0
Ozone Layer Depletion Potential (ODP) [kg CFC11 eq]	3.81E-09	6.3
Acidification Potential (AP) [kg SO_2 eq]	5.59	30.4
Eutrophication Potential (EP) [kg PO_4^{3-} eq]	0.537	19.1
Photochem. Ozone Creation Potential (POCP) [kg Ethene eq]	0.869	50.2
Abiotic Depletion non-fossil resources (ADPE) [kg Sb eq]	2.63E-04	29.2
Abiotic Depletion fossil resources (ADPF) [MJ]	25100	12.8

6 References and product standards

1. Tata Steel's EN 15804 verified EPD programme, general programme instructions, V1 January 2017

2. Tata Steel's EN 15804 verified EPD programme, product category rules part 1, V1 January 2017

3. Tata Steel's EN 15804 verified EPD programme, product category rules part 2 – structural steels, V1 April 2017

4. ISO 14044:2006, environmental management - Life cycle assessment - requirements and guidelines

5. ISO 14025:2010, environmental labels and declarations - type III environmental declarations - principles and procedures

6. ISO 14040:2006, environmental management - Life cycle assessment - principles and framework

7. EN 15804:2012+A1:2013, sustainability of construction works - environmental product declarations - Core rules for the product category of construction products

8. EN 10219:2006, Cold formed welded structural hollow sections of non-alloy and fine grain steels. Part 1: Technical delivery requirements, part 2: Tolerances, dimensions and sectional properties

9. EN 10210:2006, hot finished structural hollow sections of non-alloy and fine grain steels, part 1: Technical delivery requirements, part 2: Tolerances, dimensions and sectional properties

10. BS 7668:2016, weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification

11. EN 10225:2009, weldable structural steels for fixed offshore structures. technical delivery conditions

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14. EUROFER in cooperation with the World Steel Association, 'A methodology to determine the LCI of steel industry co-products', February 2014

15. World Steel Association: Life cycle assessment methodology report, 2017, (in press)

16. Sansom M and Avery N, Reuse and recycling rates of UK steel demolition arisings, proceedings of the Institution of Civil Engineers Engineering Sustainability 167, June 2014, Issue ES3, (Tata Steel/ EUROFER survey of members of the National Federation of Demolition Contractors (NFDC) for 'heavy structural sections and tubes')

17. CML LCA methodology, Institute of Environmental Sciences (CML), Faculty of Science, University of Leiden, Netherlands


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