

**TATA STEEL**



Trisobuild<sup>®</sup> roof cladding (0.18W/m<sup>2</sup>K)

RWL R32 240 RL32

Environmental Product Declaration



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Trisobuild® Roof Cladding (0.18W/m<sup>2</sup>K) RWL R32 240 RL32  
Environmental Product Declaration  
(in accordance with ISO 14025 and EN 15804)

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

Declaration Number: EPD-TS-2021-028

Date of Issue: 1<sup>st</sup> July 2021

Valid until: 22<sup>nd</sup> March 2025

Owner of the Declaration: Tata Steel Europe

Programme Operator: Tata Steel UK Limited, 18 Grosvenor Place, London, SW1X 7HS

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 ISO 14025

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 Europe
Product & module	Trisobuild® Roof Cladding (0.18W/m <sup>2</sup> K) RWL R32 240 RL32
U-Value	0.18W/m <sup>2</sup> K
Manufacturer	Tata Steel Europe
Manufacturing sites	Port Talbot, Llanwern and Shotton
Product applications	Construction and infrastructure
Declared unit	1m <sup>2</sup> of steel cladding system
Date of issue	1 <sup>st</sup> July 2021
Valid until	22 <sup>nd</sup> March 2025



This Environmental Product Declaration (EPD) is for Trisobuild® roof cladding manufactured by Tata Steel in the UK, using Colorcoat HPS200 Ultra® pre-finished steel and glass wool insulation. The environmental indicators are for products manufactured at Shotton with feedstock supplied from Port Talbot and Llanwern.

The information in the Environmental Product Declaration is based on production data from 2016 and 2017

EN 15804 serves as the core PCR, supported by Tata Steel's EN 15804 verified EPD programme Product Category Rules documents, and the LCA model (Cladding V2) supporting this declaration has been independently verified according to ISO 14025 <sup>[1,2,3,4,5,6,7]</sup>.

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Third party verifier

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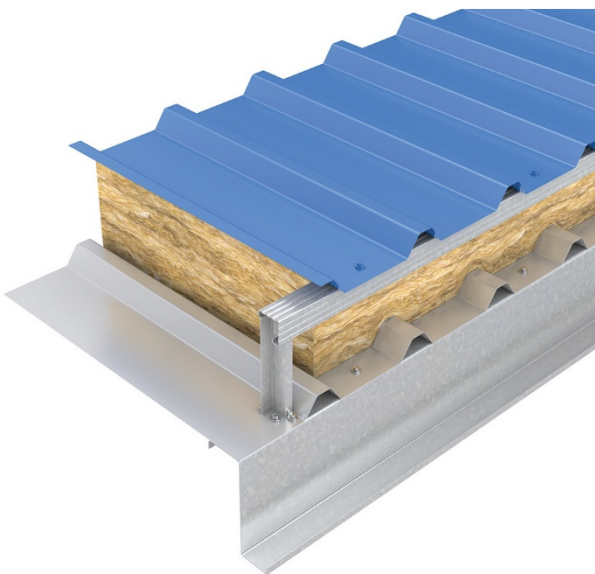
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## 2 Product information

### 2.1 Product description

Trisobuild® built-up roof systems comprise of a Colorcoat® pre-finished steel trapezoidal liner profile, a spacer system, an insulation layer and a Colorcoat® pre-finished steel external weathering profile (see Figure 1). The Trisobuild® systems incorporate a range of Tata Steel profiles and a package of Platinum® Plus pre-approved, reputable high-end components that provide tested solutions from both roof and wall constructions together with solutions for fire resistance and acoustic reduction and absorption. Our dedicated and experienced building envelope technical team are available to help develop a specification for your project and assist with project specific advice to ensure that all design aspects of the chosen cladding system meet your project requirements. The wool insulation is classified as A1 to EN 13501-1 [8] and the Trisobuild® system is approved by the Loss Prevention Certification Board (LPCB) [9].

Figure 1 Trisobuild® built-up roof system



### 2.2 Manufacturing

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

Table 1 Participating sites

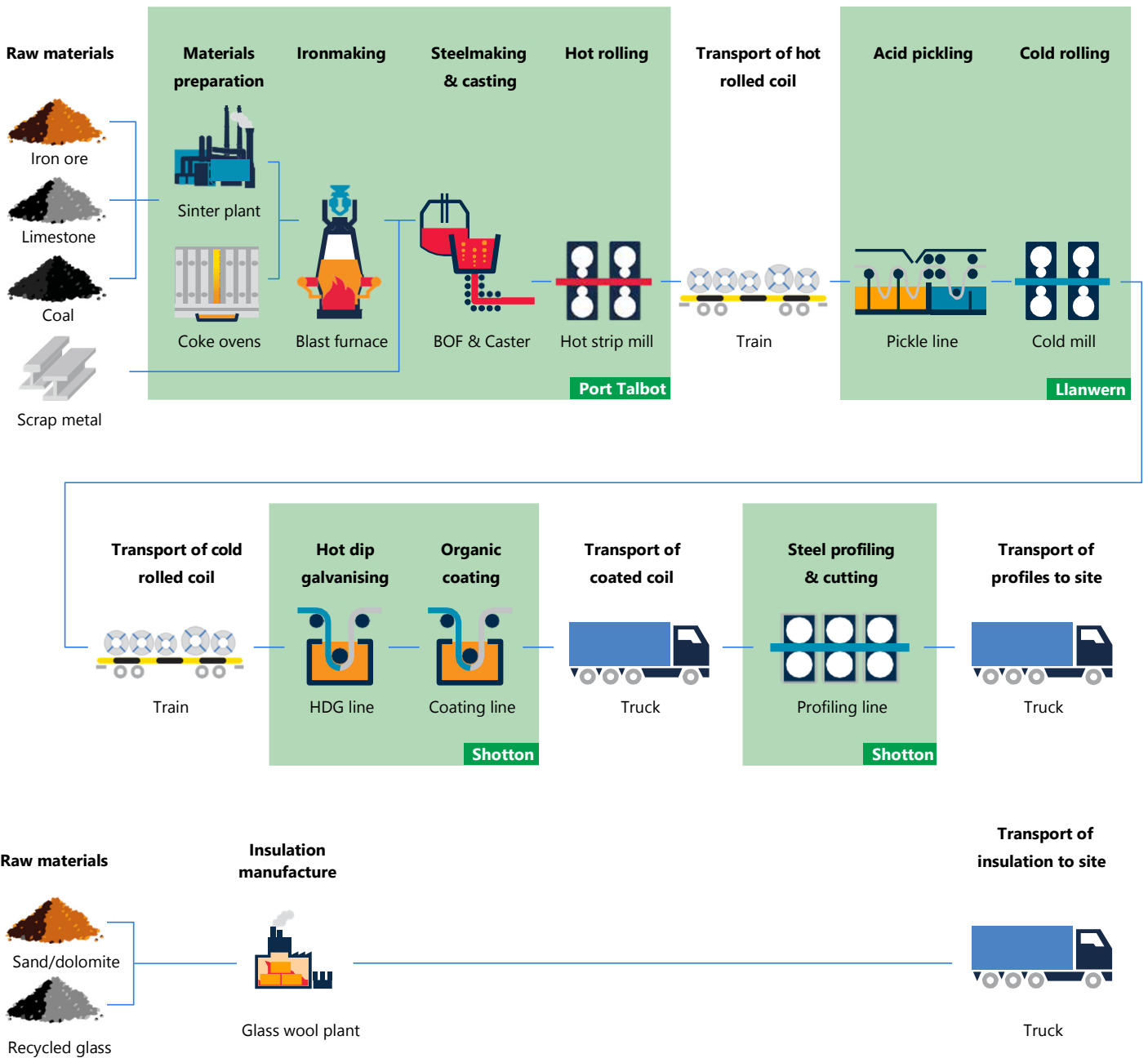
Site name	Product	Manufacturer	Country
Port Talbot	Hot rolled coil	Tata Steel	UK
Llanwern	Cold rolled coil	Tata Steel	UK
Shotton	Hot dip galvanised coil	Tata Steel	UK
Shotton	Pre-finished steel	Tata Steel	UK
Shotton	Steel cladding profiles	Tata Steel	UK

The process of steel coil 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 hot rolled coils are transported by rail, from Port Talbot to Llanwern where they are pickled and cold rolled. Following, cold rolling the coil is then transported by train to Shotton where the strip is galvanised and coated.

Pre-finished steel comprises a number of paint layers and treatments which are applied to the steel in an automated and carefully controlled process with each layer of the product having a particular function. It is the combined effect of all these layers that give the product its overall performance and ensures a material that is robust and offers the specifier a choice of colour and effect. During the organic coating process for Colorcoat HPS200 Ultra®, a Galvalloy® metallic coating is first applied to the steel coil. A pre-treatment is applied and then a primer before adding the final top coat layer in the form of liquid paint. For the vast majority of pre-finished steel products, the above topcoats are applied on the top surface only, while the reverse or back side of the strip is produced with a high performing backing coat. These are cured at elevated temperatures before being recoiled prior to use in the manufacture of the profiles used in the Trisobuild® system.

The pre-finished steel is profiled and cut into suitable lengths on a continuous production line to produce the liner and outer sheets. Steel spacer brackets and rails are formed to provide a means of attaching the outer sheet profile to the structure. They also determine the thickness of the cavity between the liner and outer profiles, into which glass wool thermal insulation is inserted during installation of the system on the building. An overview of the process from raw materials to transport of the cladding system to the construction site, is shown in Figure 2.

Figure 2 Process overview from raw materials to cladding product



Process data for the manufacture of hot and cold rolled coil at Port Talbot and Llanwern was gathered as part of the latest worldsteel data collection. For Port Talbot and Llanwern, and Colorcoat® manufacture at Shotton, the data collection was not only organised by site, but also by each process line within the 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. For the manufacture of the cladding system, process data was also collected from the profile manufacturing line on the Shotton site.

### 2.3 Technical data and specifications

The general properties of the product are shown in Table 2, and the technical specifications of the product are presented in Table 3.

### 2.4 Packaging

The products are packaged using plastic banding in order to protect them during delivery to site and prior to installation.

### 2.5 Reference service life

Steel faced cladding systems have a design life dependant on a number of factors including the building use, location, weather conditions and the specification of the products used.

Trisobuild® is available with Platinum® Plus, a system guarantee for up to 30 years, that covers the durability, structural and thermal performance of all system components and is derived from a tailored specification to suit the building function. Our reputable supply chain partners and commitment to responsible sourcing creates an enhanced building envelope system that is robust and proven. Further details of the Platinum® Plus system guarantee are available at [www.tatasteelconstruction.com](http://www.tatasteelconstruction.com).

The Trisobuild® system only uses Colorcoat® pre-finished steel products. Colorcoat HPS200 Ultra® is designed to withstand even the most demanding and aggressive environments and is used in a wide range of industrial and commercial buildings, providing super durability and corrosion resistance.

Tata Steel offer a Confidex® Guarantee directly to the industrial/commercial building owner for the weather side of this pre-finished steel product. Confidex® offers the longest and most comprehensive guarantee for pre-finished steel available in Europe. Colorcoat HPS200 Ultra® is guaranteed for up to 40 years. The exact length of the guarantee is project specific and depends upon the building location, use and colour. Appropriate inspection and maintenance can significantly extend the functional life of the profiled finished steel beyond this period. Further details of the Confidex® Guarantee are available at [www.colorcoat-online.com](http://www.colorcoat-online.com).

**Table 2 General characteristics and specification of the cladding**

Trisobuild® roof cladding	
<b>Thickness of outer sheet (mm)</b>	0.70 (Class 1) <sup>[10]</sup>
<b>Thickness of liner sheet (mm)</b>	0.70 (Class 1) <sup>[10]</sup>
<b>Core thickness of insulation (mm)</b>	240
<b>Cover width (mm)</b>	1000
<b>U-value (W/m<sup>2</sup>K)</b>	0.18
<b>Cladding weight (kg/m<sup>2</sup>)</b>	16.52
<b>CE marking</b>	External sheet, R32, 01/01/130621 and Liner sheet, RL32, 01/85/130621 to EN 14782 <sup>[11]</sup> Insulation to EN 13162 <sup>[12]</sup>
<b>Certification</b>	Certifications applicable to Tata Steel's Shotton site are; ISO 9001 <sup>[13]</sup> , ISO 14001 <sup>[14]</sup> , ISO 45001 <sup>[15]</sup> BES 6001 certification <sup>[16]</sup> LPCB Ext-B <sup>[9]</sup>

**Table 3 Technical specification of Colorcoat®**

Colorcoat® pre-finished steel	
<b>Metallic coating</b>	Colorcoat HPS200 Ultra® is supplied with Galvalloy® metallic coating which is manufactured using a mix of 95% Zinc and 5% Aluminium that conforms to EN 10346:2015 <sup>[17]</sup>
<b>Paint coating (organic)</b>	Colorcoat HPS200 Ultra® external face Colorcoat® PE15 or Colorcoat® High Reflect internal face All pre-finished steel products are fully REACH <sup>[18]</sup> compliant and chromate free
<b>Certification</b>	Certifications applicable to Tata Steel's Shotton site are; ISO 9001 <sup>[13]</sup> , ISO 14001 <sup>[14]</sup> , ISO 45001 <sup>[15]</sup> BBA certification (Colorcoat®) <sup>[19]</sup> BES 6001 certification <sup>[16]</sup> RC5, Ruv4, CPI5 certificates in accordance with EN 10169 <sup>[20]</sup>

# 3 LCA methodology

## 3.1 Declared unit

The unit being declared is 1m<sup>2</sup> of cladding system and the cladding composition is detailed in Table 4.

## 3.2 Scope

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

A1-A3: Production stage (Raw material supply, transport to production site, manufacturing)

A4 & A5: Production stage (Transport to the construction site and installation)

B1-B5: Use stage (related to the building fabric including maintenance, repair, replacement)

C1-C4: End-of-life (Deconstruction, transport, processing for recycling & reuse and disposal)

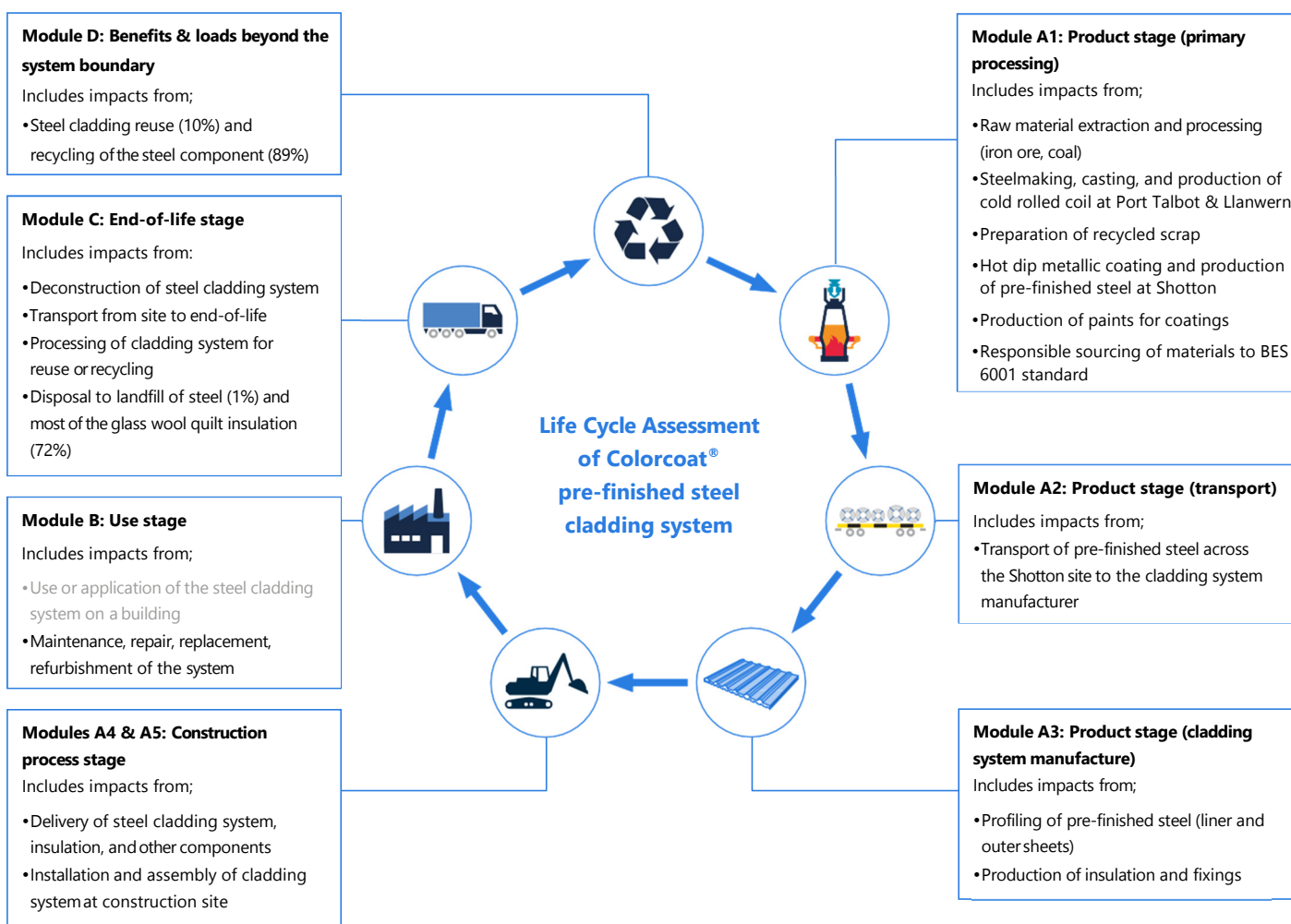
D: Reuse, recycling and recovery

The life cycle stages are explained in more detail in Figure 3.

**Table 4 Material composition of cladding system per declared unit**

Material declaration	
Declared unit (m <sup>2</sup> )	1
Insulation (kg)	3.00
Steel (kg)	13.52
Fixings & brackets (kg)	1.21

**Figure 3 Life Cycle Assessment of steel cladding system**



### 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 the insulated cladding system 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 cladding system, the GaBi Software System for Life Cycle Engineering is used <sup>[21]</sup>. The GaBi database contains consistent and documented datasets which can be viewed in the online GaBi documentation <sup>[22]</sup>.

Where possible, specific data derived from Tata Steel's own production processes were the first choice to use where available. Data was also obtained directly from the relevant suppliers, such as the paint which is used in the coating process.

To ensure comparability of results in the LCA, the basic data of the GaBi database were used for energy, transportation and auxiliary materials.

### 3.5 Data quality

The data from Tata Steel's own production processes are from 2016 and 2017, and the technologies on which these processes were based during that period, are those used at the date of publication of this EPD. All relevant background datasets are taken from the GaBi software database, and the last revision of all but three of these data sets took place less than 10 years ago. However, the contribution to impacts of these three datasets is small and relatively insignificant, and 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 <sup>[23]</sup>. 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 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 (Module A1).

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 <sup>[24]</sup>. 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).

In order to avoid allocation between different coatings produced from the same line, specific data for the manufacture of each paint type was obtained, and the amount of paint applied was considered, based upon the thickness of the coating.



### 3.7 Additional technical information

The main scenario assumptions used in the LCA are detailed below in Table 5. The end-of-life percentages are taken from a Tata Steel/ EUROFER recycling and reuse survey of UK demolition contractors carried out in 2014 <sup>[25]</sup>.

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 <sup>[26]</sup>.

### 3.8 Comparability

Care must be taken when comparing EPDs from different sources. 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 more durable product would require less maintenance and reduce the number of replacements and associated impacts over the life of the building.

**Table 5 Main scenario assumptions**

Module	Scenario assumptions
<b>A1 to A3 – Product stage</b>	Manufacturing data from Tata Steel’s sites at Port Talbot, Llanwern and Shotton are used
<b>A2 – Transport to the panel manufacturing site</b>	The Colorcoat® and Trisobuild® manufacturing facilities are both located on the Shotton site. The steel coils are transported less than 5km by road on a 28 tonne payload truck. A utilisation factor of 45% was assumed to account for empty returns
<b>A4 – Transport to construction site</b>	A transport distance of 250km by road on a 28 tonne capacity truck was considered representative of a typical installation. Utilisation factors of 30% (profiles) and 14% (insulation) were assumed to account for empty returns
<b>A5 – Installation at construction site</b>	Based on data collected from 10 typical UK installations by a Tata Steel supply chain partner for the installation of cladding systems on site. The fixing screws are made from stainless steel
<b>B1 to B5 – Use stage</b>	This stage includes any maintenance or repair, replacement or refurbishment of the cladding over the life cycle. This is not required for the duration of the reference service life of the cladding
<b>C1 – Deconstruction &amp; demolition</b>	Deconstruction is primarily removal of the cladding from the building and is also based upon supply chain partner data
<b>C2 – Transport for recycling, reuse, and disposal</b>	A transport distance of 100km to landfill or to a recycling site is assumed, while a distance of 250km is assumed for reuse. Transport is on a 25 tonne load capacity lorry with 20% utilisation to account for empty returns
<b>C3 – Waste processing for reuse, recovery and/or recycling</b>	The recycled cladding is processed in a shredder. There is no additional processing of material for reuse
<b>C4 - Disposal</b>	At end-of-life, 1% of the steel and 72% of the insulation is disposed in a landfill, based upon the findings of an NFDC survey
<b>D – Reuse, recycling, and energy recovery</b>	At end-of-life, 89% of the steel is recycled and 10% of the steel profiles are reused, in accordance with the findings of an NFDC survey

# 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	X	X	X	X	X	X	X	MND	MND	X	X	X	X	X

X = Included in LCA; MND = module not declared

## Environmental impact:

1m<sup>2</sup> of Trisobuild® roof cladding

Parameter	Unit	A1 – A3	A4	A5	B1 - B5	C1	C2	C3	C4	D
GWP	kg CO <sub>2</sub> eq	4.69E+01	5.27E-01	6.87E-01	0.00E+00	2.27E-01	3.21E-01	1.45E-01	3.42E-02	-2.34E+01
ODP	kg CFC11 eq	9.55E-07	1.05E-16	1.34E-15	0.00E+00	4.52E-17	6.38E-17	6.26E-12	1.99E-16	-5.64E-08
AP	kg SO <sub>2</sub> eq	1.61E-01	1.34E-03	4.94E-03	0.00E+00	2.15E-03	8.33E-04	4.30E-04	2.05E-04	-4.83E-02
EP	kg PO <sub>4</sub> <sup>3-</sup> eq	1.36E-02	3.19E-04	9.70E-04	0.00E+00	4.62E-04	1.99E-04	4.09E-05	2.32E-05	-3.63E-03
POCP	kg Ethene eq	2.36E-02	-4.99E-04	6.19E-04	0.00E+00	2.94E-04	-3.12E-04	2.97E-05	1.57E-05	-1.11E-02
ADPE	kg Sb eq	2.85E-03	1.92E-08	6.26E-06	0.00E+00	8.29E-09	1.17E-08	5.93E-08	1.26E-08	-5.84E-04
ADPF	MJ	5.35E+02	7.12E+00	7.53E+00	0.00E+00	3.08E+00	4.35E+00	2.07E+00	4.79E-01	-2.27E+02

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:**

1m<sup>2</sup> of Trisobuild® roof cladding

Parameter	Unit	A1 – A3	A4	A5	B1 – B5	C1	C2	C3	C4	D
PERE	MJ	5.21E+01	1.70E-01	4.35E-01	0.00E+00	7.33E-02	1.04E-01	8.67E-01	6.28E-02	9.36E+00
PERM	MJ	4.65E+00	0.00E+00	8.53E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.65E-01
PERT	MJ	5.68E+01	1.70E-01	1.29E+00	0.00E+00	7.33E-02	1.04E-01	8.67E-01	6.28E-02	8.90E+00
PENRE	MJ	6.14E+02	7.67E+00	8.23E+00	0.00E+00	3.31E+00	4.68E+00	3.21E+00	5.34E-01	-2.31E+02
PENRM	MJ	1.56E+01	0.00E+00	1.43E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.14E+00
PENRT	MJ	6.29E+02	7.67E+00	9.66E+00	0.00E+00	3.31E+00	4.68E+00	3.21E+00	5.34E-01	-2.32E+02
SM	kg	5.97E-01	0.00E+00	-1.47E-01	0.00E+00	0.00E+00	0.00E+00	-1.20E+01	0.00E+00	-5.97E-02
RSF	MJ	5.28E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.28E-09
NRSF	MJ	8.02E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-8.02E-08
FW	m <sup>3</sup>	1.77E-01	4.53E-04	1.46E-03	0.00E+00	1.96E-04	2.77E-04	1.88E-03	2.52E-03	-8.60E-02

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:**

1m<sup>2</sup> of Trisobuild® roof cladding

Parameter	Unit	A1 – A3	A4	A5	B1 – B5	C1	C2	C3	C4	D
HWD	kg	2.57E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.57E-01
NHWD	kg	1.83E+00	0.00E+00	4.48E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E+00	-1.82E-01
RWD	kg	1.11E-02	1.20E-05	6.03E-05	0.00E+00	5.18E-06	7.31E-06	3.84E-04	6.66E-06	-6.16E-04
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	7.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E+01	0.00E+00	-7.35E-03
MER	kg	8.94E-03	0.00E+00	6.56E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-8.94E-04
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HWD = Hazardous waste disposed

NHWD = Non-hazardous waste disposed

RWD = Radioactive waste disposed

CRU = Components for reuse

MFR = Materials for recycling

MER = Materials for energy recovery

EEE = Exported electrical energy

EET = Exported thermal energy

## 5 Interpretation of results

Figure 4 shows the relative contribution per life cycle stage for each of the seven environmental impact categories for 1m<sup>2</sup> of Tata Steel's Trisobuild® roof cladding. Each column represents 100% of the total impact score, which is why all the columns have been set with the same length. A burden is shown as positive (above the 0% axis) and a benefit is shown as negative (below the 0% axis). The main contributors across all impact categories are A1-A3 (burdens) and D (benefits beyond the system boundary).

The manufacture of the cold rolled coil during stage A1-A3 is responsible for between 50% and 75% of each impact in most of the categories, specifically, the conversion of iron ore into liquid steel which is the most energy intensive part of the cladding manufacturing process. The manufacture of the glass wool insulation is also a significant contributor to each environmental impact and is generally responsible for between 20% and 40% of the A1-A3 total. The exceptions to this are in the GWP category, where the insulation contribution is only 7%, and for the Ozone Depletion Potential (ODP) indicator, where the manufacture of the glass wool insulation is responsible for less than 5% of the total. The main contribution to A1-A3 in the ODP category is actually from the manufacture of the paint coating, which represents about 65% of the total impact.

The primary site emissions come from use of coal and coke in the blast and basic oxygen furnaces, as well as combustion of the process gases. These processes, together with the manufacture of the wool insulation, give rise to emissions of CO<sub>2</sub>, which contributes 95% of the Global Warming Potential (GWP), and sulphur oxides, which are responsible for over half of the impact in the Acidification Potential (AP) category. In addition, oxides of nitrogen are emitted which contribute around 25% of the A1-A3 Acidification Potential, and more than 50% of the Eutrophication Potential (EP), and ammonia, which is also significant. The combined emissions of sulphur and nitrogen oxides, together with emissions of carbon monoxide, methane, and VOCs all contribute to the Photochemical Ozone indication (POCP).

Figure 4 clearly indicates the relatively small contribution to each impact from the other life cycle stages, A4 and A5, and C1 through to C4. Of these stages, the most significant contributions are from stages A5 (installation of the product on the building) and C1 (deconstruction at end of life) to the Acidification and Eutrophication Potentials. These are mainly the result of nitrogen oxides emissions from the combustion of diesel fuel used to power site machinery such as fork lift trucks, scissor lifts and cherry pickers. The emission of sulphur dioxide also contributes to the Acidification Potential indicator for A5, with approximately 20% of the total impact coming from the manufacture of the stainless steel screws that fix the cladding to the building.

Figure 4 LCA results for the cladding system



Module D values are largely 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 cladding is modelled with a credit given as if it were re-melted in an Electric Arc Furnace and substituted by the same amount of steel produced in a Blast Furnace<sup>[24]</sup>. This contributes a significant reduction to most of the environmental impact category results, with the specific emissions that represent the burden in A1-A3, essentially the same as those responsible for the impact reductions in Module D.

Referring to the LCA results, the impact in Module D for the Use of Renewable Primary Energy indicator (PERT) is different to other impact categories, being a burden or load rather than a benefit. Renewable energy consumption is strongly related to the use of electricity, during manufacture, and as the recycling (EAF) process uses significantly more electricity than primary manufacture (BF/BOS), there is a positive value for renewable energy consumption in Module D but a negative value for non-renewable energy consumption.

## 6 References and product standards

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