CA | GROUP

EPD
THIRD PARTY VERIFIED ISO 14025 & EN 15804

CA Building Products SolarWall® unglazed Transpired Solar Collector (uTSC) incorporating CA 32 1000W external profile

Environmental Product Declaration

Owner of the Declaration: CA Group Ltd, County Durham, DL14 9SF
Programme Operator: Tata Steel UK Limited, 18 Grosvenor Place, London, SW1X 7HS

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CA Building Products SolarWall® unglazed Transpired Solar Collector (uTSC)
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-2021-027
Date of Issue: 7th June 2021
Valid until: 22nd March 2025

Owner of the Declaration: CA Group Ltd, County Durham, DL14 9SF
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	CA Group Ltd
Product & module	SolarWall® unglazed Transpired Solar Collector (uTSC)
Manufacturer	CA Building Products & Tata Steel Europe
Manufacturing sites	Evenwood, Shotton, Llanwern and Port Talbot
Product applications	Construction and infrastructure
Declared unit	1m^2 of steel cladding system
Date of issue	7th June 2021
Valid until	22nd March 2025

This Environmental Product Declaration (EPD) is for SolarWall® unglazed Transpired Solar Collector (uTSC) manufactured by CA Building Products in the UK, using Colorcoat HPS200 Ultra® or Colorcoat Prisma® pre-finished steel. The environmental indicators are for products manufactured at CA Building Products in Evenwood with feedstock supplied from Shotton.

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 [1,2,3,4,5,6,7].

Third party verifier

Olivier Muller, PwC Stratégie - Développement Durable, PricewaterhouseCoopers Advisory,
63, rue de Villiers, 92208 Neuilly-sur-Seine, France

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2 Product information

2.1 Product Description

The SolarWall® unglazed Transpired Solar Collector (uTSC) is an active solar air heating system for buildings.

Comprising of a project-specific spacer system along with a fully perforated Colorcoat® pre-finished steel external weathering profile, the system is installed onto a building's southerly facing façade to maximise solar exposure.

The SolarWall® unglazed Transpired Solar Collector system is independently assessed by Agrément [8].

- Available in a wide range of external profile options
- Significant reductions in building energy use and CO_2 emissions
- Independently proven to provide up to 50% savings in heating costs
- Over 500W of thermal power generated per m^2 on a clear day
- Solar energy conversion of up to 80%
- Can heat ambient air by as much as +45°C
- System performance independently tested in accordance with ISO 9806 [9] for Solar Thermal Collectors
- Included within the UK government's SBEM calculation methodology for EPC & BRUKL certification
- Solar 'A' Mark certified by the Solar Air Heating World Industries Association (SAHWIA) [10]
- Colorcoat® products specifically developed to maximise solar absorption performance
- System design specifically engineered to suit individual building requirements
- LPCB tested to LPS 1181 achieving 'EXT-A15', 'EXT-A60' or 'EXT-A120' status when installed on top of CA Group Twin-Therm® insulated wall system [11]

2.2 Manufacturing

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

Table 1 Participating sites

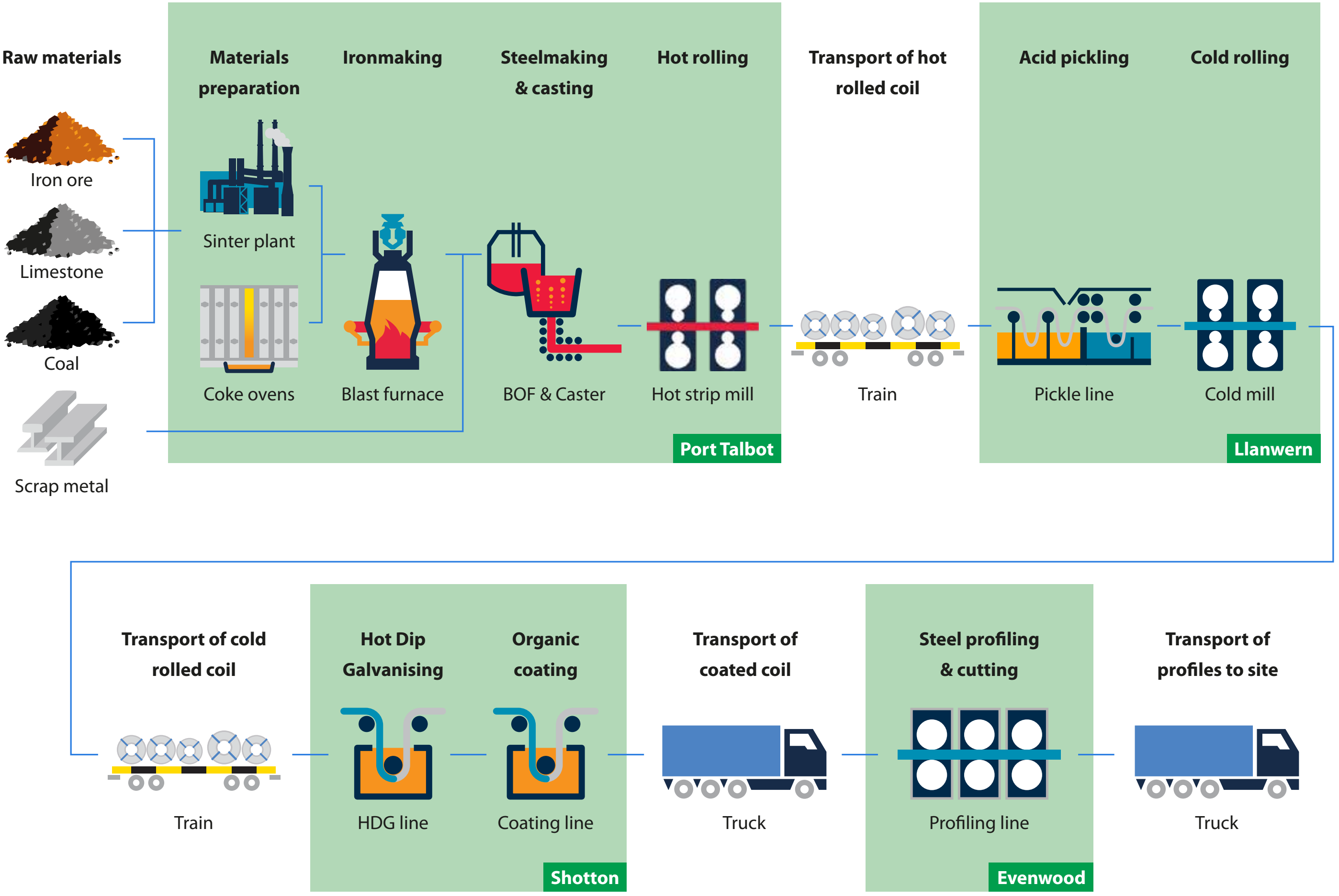
Site name	Product	Manufacturer	Country
Port Talbot	Hot rolled coil	Tata Steel	UK
Llanwern	Cold rolled coil	Tata Steel	UK
Shotton	Hot dip galvanised coil	Tata Steel	UK
Shotton	Pre-finished steel	Tata Steel	UK
Evenwood	uTSC cladding system	CA Building Products	UK

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® and Colorcoat Prisma®, 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(s) 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 cladding system.

The pre-finished steel is transported by road to be perforated and is then delivered to CA Group's manufacturing facility at Evenwood. The coated steel is then profiled and cut into suitable lengths on a continuous production line to produce the final sheets. Steel spacer brackets and rails are formed to provide a means of attaching the sheet profile to the structure. An overview of the process from raw materials to transport of the cladding system to the construction site, is shown in Figure 1.

Figure 1 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 manufacturing line on the CA Group site at Evenwood.

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 profiled sheets are packaged using responsibly sourced timber and secured with plastic or steel strapping. The outer sheets in each pack are protected by scrap steel sheets from the coil ends, prior to their transportation to the construction site.

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 pre-finished steel product.

Products specified with Colorcoat HPS200 Ultra® are designed to withstand even the most demanding and aggressive environments and are used in a wide range of industrial and commercial buildings, providing super durability and corrosion resistance.

Three layer Colorcoat Prisma® not only uniquely pushes the boundaries for UV performance but also outperforms the highest European corrosion resistance standards [12] and makes it ideal for commercial, retail, warehouse, public sector and superior aesthetic buildings which are built to last.

Table 2 General characteristics and specification of the cladding

	SolarWall® unglazed Transpired Solar Collector (uTSC)
Thickness of outer sheet (mm)	0.7 (Class 1) [13]
Cover width (mm)	1000
Panel weight (kg/m²)	6.77
CE marking	Profiled sheets to EN 14782 [14] Spacer system to ETA 17/0456 [15]
Certification	Certifications applicable to CA Group Evenwood site are; ISO 9001 [16], ISO 14001 [17] LPCB LPS 1181 Ext-B [11] Kiwa BDA Agrément certification [8]

Table 3 Technical specification of Colorcoat®

	Colorcoat® pre-finished steel
Metallic coating	Colorcoat HPS200 Ultra® and Colorcoat Prisma® are supplied with Galvalloy® metallic coating which is manufactured using a mix of 95% Zinc and 5% Aluminium that conforms to EN 10346:2015 [18]
Paint coating (organic)	Colorcoat HPS200 Ultra® or three layer Colorcoat Prisma® external face All pre-finished steel products are fully REACH [19] compliant and chromate free
Certification	Certifications applicable to Tata Steel's Shotton site are; ISO 9001 [16], ISO 14001 [17], ISO 45001 [20] BES 6001 certification [21] BBA certification (Colorcoat®) [22] RC5, Ruv4, CPI5 certificates in accordance with EN 10169 [12]

3 LCA methodology

3.1 Declared unit

The unit being declared is 1m^2 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;

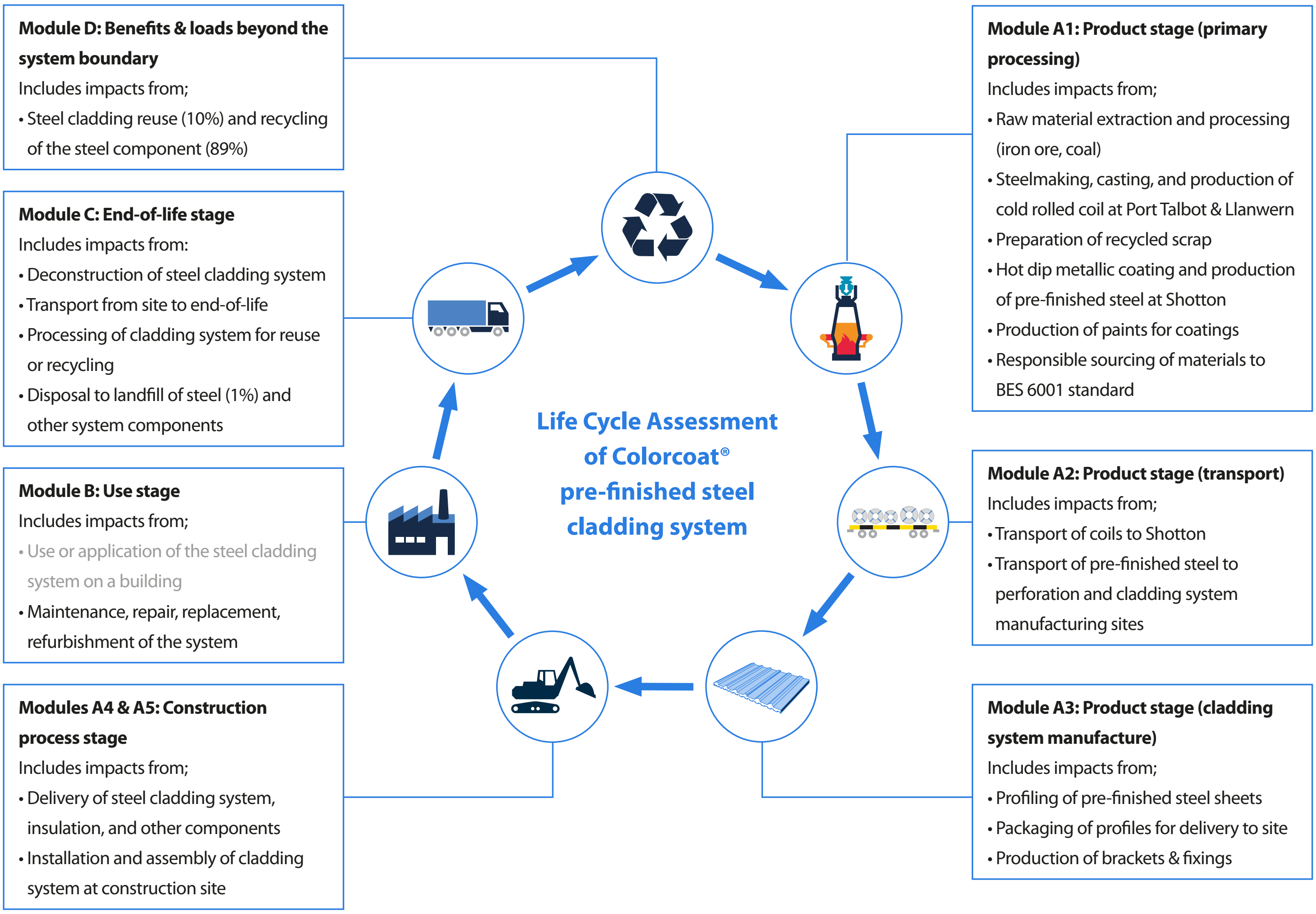
A1-3: Production stage (Raw material supply, transport to production site, manufacturing)
A4 & A5: Production stage (Transport to the construction site and installation)
B1-5: Use stage (related to the building fabric including maintenance, repair, replacement)
C1-4: End-of-life (Deconstruction, transport, processing for recycling & reuse and disposal)
D: Reuse, recycling and recovery

The life cycle stages are explained in more detail in Figure 2

Table 4 Material composition of cladding system per declared unit

	Material declaration
Declared unit (m^2)	1
Steel (kg)	6.77
Fixings & brackets (kg)	2.27

Figure 2 Life Cycle Assessment of steel cladding system



Module D: Benefits & loads beyond the system boundary
Includes impacts from;
- Steel cladding reuse (10%) and recycling of the steel component (89%)

Module C: End-of-life stage
Includes impacts from:
- Deconstruction of steel cladding system
- Transport from site to end-of-life
- Processing of cladding system for reuse or recycling
- Disposal to landfill of steel (1%) and other system components

Module B: Use stage
Includes impacts from;
- Use or application of the steel cladding system on a building
- Maintenance, repair, replacement, refurbishment of the system

Modules A4 & A5: Construction process stage
Includes impacts from;
- Delivery of steel cladding system, insulation, and other components
- Installation and assembly of cladding system at construction site

Module A1: Product stage (primary processing)
Includes impacts from;
- Raw material extraction and processing (iron ore, coal)
- Steelmaking, casting, and production of cold rolled coil at Port Talbot & Llanwern
- Preparation of recycled scrap
- Hot dip metallic coating and production of pre-finished steel at Shotton
- Production of paints for coatings
- Responsible sourcing of materials to BES 6001 standard

Module A2: Product stage (transport)
Includes impacts from;
- Transport of coils to Shotton
- Transport of pre-finished steel to perforation and cladding system manufacturing sites

Module A3: Product stage (cladding system manufacture)
Includes impacts from;
- Profiling of pre-finished steel sheets
- Packaging of profiles for delivery to site
- Production of brackets & fixings

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 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 [23]. The GaBi database contains consistent and documented datasets which can be viewed in the online GaBi documentation [24].

Where possible, specific data derived from the production processes of Tata Steel and CA Building Products 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 the production processes of Tata Steel and CA Building Products 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 [25]. 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 [26]. 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 in Table 5. The end-of-life percentages are based upon a Tata Steel/ EUROFER recycling and reuse survey of UK demolition contractors carried out in 2014 [27].

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 [28].

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 datasets 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
A1 to A3 – Product stage	Manufacturing data from Tata Steel's sites at Port Talbot, Llanwern and Shotton are used, as well as data from CA Group in Evenwood
A2 – Transport to the profile manufacturing site	The perforation is carried out by a third party, and the coils are taken from Shotton, 320km by road on a 28 tonne payload truck. The perforated Colorcoat® coils are then transported directly to profiler, a distance of 420km by road on a 28 tonne payload truck. A utilisation factor of 45% was assumed, to account for empty returns
A4 – Transport to construction site	A transport distance of 250km by road on a 28 tonne capacity truck was considered representative of a typical installation. A utilisation factor of 30% was assumed, to account for empty returns
A5 – Installation at construction site	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
B1 to B5 – Use stage	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
C1 – Deconstruction & demolition	Deconstruction is primarily removal of the cladding from the building and is also based upon supply chain partner data
C2 – Transport for recycling, reuse, and disposal	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
C3 – Waste processing for reuse, recovery and/or recycling	The recycled cladding is processed in a shredder. There is no additional processing of material for reuse
C4 - Disposal	At end-of-life, 1% of the steel is disposed in a landfill, based upon the findings of an NFDC survey
D – Reuse, recycling, and energy recovery	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^2 of CA SolarWall® unglazed Transpired Solar Collector (uTSC)

Parameter	Unit	A1 – A3	A4	A5	B1 - B5	C1	C2	C3	C4	D
GWP	kg CO$_2$ eq	2.71E+01	1.80E-01	5.77E-01	0.00E+00	2.27E-01	1.33E-01	7.27E-02	1.04E-03	-1.18E+01
ODP	kg CFC11 eq	5.40E-07	3.59E-17	1.17E-16	0.00E+00	4.52E-17	2.63E-17	3.14E-12	6.04E-18	-5.32E-08
AP	kg SO$_2$ eq	6.99E-02	4.49E-04	4.33E-03	0.00E+00	2.15E-03	3.44E-04	2.15E-04	6.22E-06	-2.43E-02
EP	kg PO$_4^{3-}$ eq	6.70E-03	1.07E-04	9.32E-04	0.00E+00	4.62E-04	8.20E-05	2.05E-05	7.05E-07	-1.85E-03
POCP	kg Ethene eq	1.24E-02	-1.66E-04	5.88E-04	0.00E+00	2.94E-04	-1.29E-04	1.49E-05	4.78E-07	-5.52E-03
ADPE	kg Sb eq	1.49E-03	6.58E-09	1.81E-08	0.00E+00	8.29E-09	4.83E-09	2.97E-08	3.82E-10	-2.91E-04
ADPF	MJ	3.16E+02	2.44E+00	6.22E+00	0.00E+00	3.08E+00	1.79E+00	1.04E+00	1.45E-02	-1.16E+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^2 of CA SolarWall® unglazed Transpired Solar Collector (uTSC)

Parameter	Unit	A1 – A3	A4	A5	B1 - B5	C1	C2	C3	C4	D
PERE	MJ	2.97E+01	5.82E-02	1.54E-01	0.00E+00	7.33E-02	4.27E-02	4.35E-01	1.91E-03	4.15E+00
PERM	MJ	3.26E+00	0.00E+00	8.53E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.22E-01
PERT	MJ	3.29E+01	5.82E-02	1.01E+00	0.00E+00	7.33E-02	4.27E-02	4.35E-01	1.91E-03	3.83E+00
PENRE	MJ	3.56E+02	2.63E+00	6.70E+00	0.00E+00	3.31E+00	1.93E+00	1.61E+00	1.62E-02	-1.18E+02
PENRM	MJ	9.59E+00	0.00E+00	1.43E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-9.45E-01
PENRT	MJ	3.65E+02	2.63E+00	8.13E+00	0.00E+00	3.31E+00	1.93E+00	1.61E+00	1.62E-02	-1.19E+02
SM	kg	2.51E-01	0.00E+00	-9.04E-02	0.00E+00	0.00E+00	0.00E+00	-5.94E+00	0.00E+00	-2.48E-02
RSF	MJ	1.07E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.06E-09
NRSF	MJ	1.63E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.61E-08
FW	m^3	9.52E-02	1.55E-04	4.52E-04	0.00E+00	1.96E-04	1.14E-04	9.41E-04	7.67E-05	-4.31E-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^2 of CA SolarWall® unglazed Transpired Solar Collector (uTSC)

Parameter	Unit	A1 – A3	A4	A5	B1 – B5	C1	C2	C3	C4	D
HWD	kg	1.30E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.28E-01
NHWD	kg	9.34E-01	0.00E+00	2.98E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.98E-02	-9.20E-02
RWD	kg	4.53E-03	4.11E-06	1.25E-05	0.00E+00	5.18E-06	3.02E-06	1.93E-04	2.02E-07	-4.38E-04
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.98E-01	0.00E+00	0.00E+00	0.00E+00
MFR	kg	6.46E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.94E+00	0.00E+00	-6.36E-03
MER	kg	2.76E-03	0.00E+00	6.56E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-2.72E-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

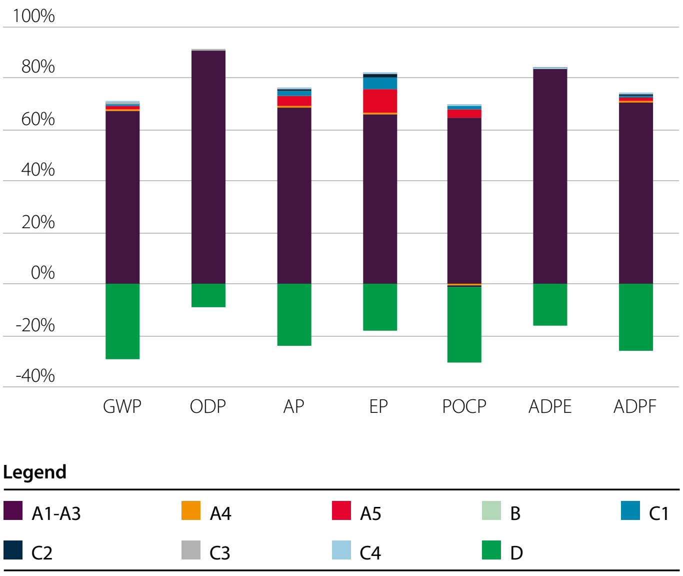
Figure 3 shows the relative contribution per life cycle stage for each of the seven environmental impact categories for 1m^2 of CA Building Products SolarWall® cladding. Each column represents 100% of the total impact score, which is why all the columns have been set with the same length. A burden is 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 approximately 90% 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 main contribution to A1- A3 in the ODP category is actually from the manufacture of the paint coating, which represents almost 100% of the total impact.

The primary site emissions come from use of coal and coke in the blast furnace, and from the injection of oxygen into the basic oxygen furnace, as well as combustion of the process gases. These processes give rise to emissions of CO_2, which contributes almost 96% of the Global Warming Potential (GWP), and sulphur oxides, which are responsible for over 50% of the impact in the Acidification Potential (AP) category. In addition, oxides of nitrogen are emitted which contribute more than one third of the A1-A3 Acidification Potential, and over 80% of the Eutrophication Potential (EP). 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 3 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 a significant proportion of the total impact coming from the manufacture of the stainless steel screws that fix the cladding to the building.

Figure 3 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 [26]. 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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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. Kiwa BDA Agrément product certification, Kiwa Building Products
9. ISO 9806:2017, Solar energy – Solar thermal collectors – Test methods
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Tata Steel
Shotton Works
Deeside
Flintshire
CH5 2NH
United Kingdom
T: +44 (0) 1244 812345

CA Building Products
Evenwood Industrial Estate
Copeland Road, Evenwood
Co. Durham
DL14 9SF
T: +44 (0) 1388 834242
E: technical@cagroup.co.uk
www.cagroup.co.uk

Colorcoat Connection® helpline
T: +44 (0) 1244 892434
E: colorcoat.connection@tatasteeleurope.com
Tata Steel UK Limited is registered in England under number 2280000 with registered office at 18 Grosvenor Place, London, SW1X 7HS

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