SUSTAINABILITY AND LIFE CYCLE ANALYSIS DATA IN CONSTRUCTION MATERIALS CERTIFICATIONS – A CASE STUDY FROM THE STEEL INDUSTRY

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Keywords: Life Cycle Analysis (LCA), Environmental Product Declarations (EPD’s), Social Responsibility, Human Rights, Value Chain, Certification.

Abstract

Life Cycle Analysis (LCA), Environmental Product Declarations (EPD’s) and other social and environmental data are used by construction material certifications to provide confidence to construction clients and public procurement processes that sustainability impacts are understood and that performance is being managed to reduce negative impacts.

This paper explores the drivers behind this certification approach through the context of the CARES Sustainable Constructional Steels certification scheme and its markets. It explores the trends shown by data collection and the challenges and opportunities for improvement and differentiation.

The findings suggest that requests for information from clients are getting more sophisticated and detailed, with the scope of criteria expanding to include human rights and social responsibility issues and are increasingly being used in procurement processes. The use of EPD’s to demonstrate environmental performance is becoming more common. They have shown that the difference between supplier efficiency is more important than the transport impacts and distances. Value could be gained by integrated LCA and EPD with wider sustainability information and making it accessible in other formats, such as, building information modelling systems.

1. Introduction

1.1 An Introduction to CARES

CARES is a Certification body covering the steel sector, operating in over 40 countries globally. It provides several product certification schemes covering reinforcing steel and associated products for use primarily in construction, most significantly the Steel for the Reinforcement of Concrete (CARES SRC) scheme[i]. This scheme covers the entire supply chain for reinforcing steels, including welding and the application of mechanical couplers, thereby ensuring reinforcement is correctly produced, processed and delivered to site.

1.2 CARES Sustainable Constructional Steel (SCS) Scheme

The CARES Sustainable Constructional Steel (SCS) Scheme[ii] was specifically developed for the constructional steel supply chain and launched in 2011 enabling suppliers to declare the sustainability performance of their products using several relevant sectoral Environmental, Social and Economic Key Performance Indicators (KPIs).

Its objective is to provide independent certification of the sustainability performance of steel products. The scheme provides a dynamic framework to measure, monitor and improve the sustainability performance of products and provides a robust and transparent mechanism for communicating the sustainability performance of steel products to designers, specifiers and clients.

Firms wishing to achieve certification to the CARES SCS scheme must first operate in accordance with the CARES Steel for the Reinforcement of Concrete (CARES SRC) scheme. This ensures the use of a management system for quality according to ISO 9001[iii], an environmental management system to ISO 14001[iv] and a health and safety management system to OHSAS 18001[v].

The assessment procedure commences with a detailed review of the firm’s certificates and Management System Manuals against the requirements of the standards. Providing the requirements are met, an assessment of the firm’s application form is completed. Once an application is accepted, the firm completes a self-evaluation workbook, which includes gathering evidence for how it meets over 100 criteria covering the identification, collection, auditing and reporting of environmental, social, labour, business ethics and local economic impacts. Developed by a group of industry experts, they cover most of the supply chain from the production of the steel through its processing to the delivery of the finished product to the construction site. A two-stage audit process, where the evidence is checked for each criterion at each site, is completed by CARES auditors in an annual cycle. Any non-conformances are highlighted and repeat audits conducted to confirm conformance if required.

2. Using Sustainability To Differentiate In The Steel And Construction Sectors

Dodge's World Green Building Trends 2016 Report[vi], which surveyed Architects, Contractors, Specialist Consultants, Clients and Engineers in US, Mexico, Brazil, Colombia, Germany, Poland, UK, Saudi Arabia, South Africa, Singapore, India, China and Australia, identified 8 criteria used to evaluate "green" construction products, which is shown in Figure 1. As can be seen, a wide range of sustainability criteria are used, and in many cases, multiple criteria are being used together. This survey was also undertaken in 2008 and 2012 (although EPD were not included in the criteria until 2015) and all have seen drops in importance, suggesting EPD are becoming more important as other criteria are diminishing in importance.

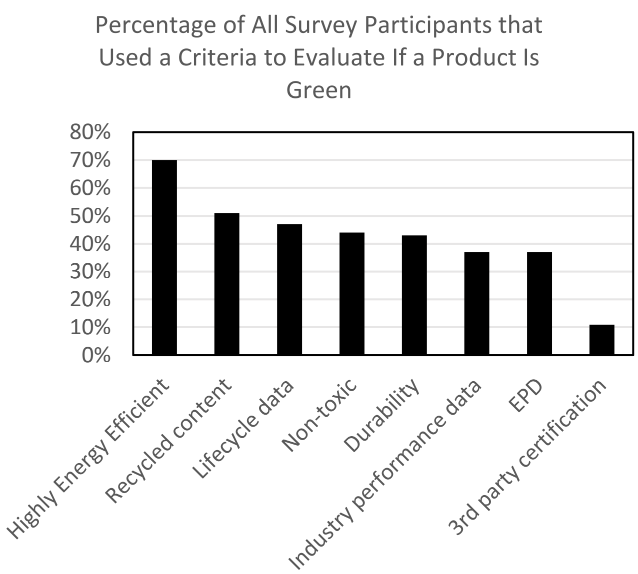

Figure 1: Criteria used to evaluate green products[vii]

PWC in their 2011 study of the UK sustainable construction materials market, Materials Gains in Sustainability, stated "Businesses in the sector clearly understand the complexity of sustainability, embracing factors other than simply carbon. Some of the strongest opinions expressed during interviews were about the potentially misleading picture created by overemphasising carbon and neglecting other environmental factors such as weight, recycling and water use."

In 2012, WorldSteel states the global Steel Industry was responsible for using 11% of all hard coal and producing 7% of global CO2 emissions[viii]. Therefore, as a sector, it is important to demonstrate that steel has been produced as sustainably as possible. The major determinant of impact for steel production is the technology used. Electric Arc Furnace (EAF) steel production can use 100% scrap, whereas the Blast Oxygen Furnace (BOF) and Direct Reduced Iron (DRI) use iron ore, though a proportion of scrap is introduced into the BOF process.

Historically, the BOF steel sector has focussed on the recyclability of its steel rather than recycled content, and developed its own methodology for assessing and reporting life cycle assessment (LCA) studies, the World Steel Association (worldsteel) LCA methodology[ix]. As this method differs from the LCA methodology and resulting Environmental Product Declarations (EPD) provided in the European Standard for all construction products, EN 15804[x], much of the data provided to the worldsteel methodology by the steel industry cannot be used easily alongside other LCA data. Additionally, most of the worldsteel data is only provided at a high level, e.g. for Europe rather than for individual sites.

Verified EPD data to EN 15804 is available for steel products across the three main EPD programmes. In the German EPD programme, IBU[xi], EPD are provided for Bauforumstahl structural steel produced using both BOF and EAF from across Europe, for Vallourec's Hollow Section produced in Germany using BOF, for Celsa's structural steel produced using EAF in Spain and Poland, and for JSW's structural steel produced using BOF in India. 5 EPD for carbon steel reinforcement are also cross-listed from the International EPD scheme.

In the Norwegian programme, there are 3 EPD for carbon steel reinforcement produced in Norway and Lithuania and 2 generic EPD for Norway. For structural steel, 9 companies with sites in Norway, Sweden, Finland, Latvia, Lithuania and Poland have produced 25 EPD, and there for 4 Generic EPD for Norwegian structural steel.

In the UK programme, the BRE Verified EN 15804 EPD scheme[xii], there are 19 EPD for CARES approved suppliers, producing carbon steel reinforcement in Turkey, Italy, France, Spain, UAE, Qatar and Portugal, using EAF or DRI. There are also 2 EPD for structural steel produced by UK CARES approved suppliers in the UAE with DRI and in Turkey with EAF, and a generic EPD for carbon steel reinforcement produced by CARES approved suppliers.

The International EPD® programme provide EPD for merchant bar produced in Switzerland, France and Italy by EAF, Bluescope's EPD for structural steel produced by BOF in Australia, OneSteel's EPDs for structural steel, reinforcing steel, bar and mesh all made by a mix of EAF and BOF in Australia, 4 EPD for Celsa carbon steel reinforcement made with EAF in Norway and used across the 4 Nordic states, 5 EPD for Italian producers of carbon steel reinforcement using EAF, and 1 EPD for pre-stressed reinforcement produced using EAF in Sweden. The French EPD Programme, FDES[xiii], does not provide any Verified EPD for structural or carbon reinforcing steel.

2.1 What Data Is Currently Available For UK Structural Steel and Carbon Steel Reinforcement Products

As discussed above, there are numerous EPD for structural steel and carbon steel reinforcement produced around the world; however, there are no EPD specifically for UK produced steel. The IBU generic Bauforumstahl EPD for structural steel does include production by British Steel (formerly Tata Steel) at their Scunthorpe and Lackenby (Teeside) sites in the UK, but also covers European production by Dillinger Hütte, GTS Industries, Ilsenburger Grobblech GmbH, ArcelorMittal, Peiner Träger GmbH and Stahlwerk Thüringen GmbH.

A 2015 report on the UK Iron and Steel sector prepared for the Department of Energy and Climate Change and Department of Business, Innovation and Skills[xiv], stated "carbon intensity in the UK in 2011 averaged around 2.3 tonnes CO_2 per tonne of steel: integrated sites have an average carbon intensity of 2.2 tonnes CO_2 per tonne of crude steel whereas EAF sites have a lower average of 0.6 tonnes of CO_2 per tonne of steel[xv]. This value for average UK steelmaking was much lower than India and China (with carbon intensities in the range of 3.1-3.8 tonnes CO_2 in 2011) but somewhat higher than other countries such as Brazil (1.25 tonnes CO_2 – due to the use of hydro-power) and Mexico (1.6 tonnes CO_2 – due to a higher EAF capacity)[xvi]". The average impact of structural steel across Europe, which includes UK production at Scunthorpe and Lackenby, is reported as 1735 kg CO_2 eq/tonne in the Bauforumstahl EPD.

<u>Impact of Transport of steel to the UK</u>

The typical impact of transport of steel in the UK is estimated by British Steel to be 10 kg CO_2 per tonne based on a typical delivery distance of less than 150 km. By contrast, European steel, e.g. from Ukraine, may travel up to 3,000 km to the UK by road with an impact of 75 g CO2/tonne.km[xvii], giving an impact of up to 225 kg CO_2 eq/tonne. Shipping from China to the UK (say 18,000 km at 14g CO_2/tonne.km[xviii]) would have an impact of 252 kg CO_2/tonne or from Brazil (say 10,000 km) 140 kg CO_2/tonne.

These transport impacts compare to the typical impact of European structural steel given in the Bauforumstahl EPD of 1735 kg CO_2 eq/tonne and the typical impact from the CARES EPD for Carbon steel reinforcing bar (secondary production route – scrap) of 839 kg CO_2 eq/tonne. Thus it can be seen that the impact of transport across Europe adds around 13% to the impact of European structural steel and 27% to the impact of CARES reinforcing steel.

2.3 How Authoritative Is The Data Used By CARES?

The certification process is based on an initial review of application information including management system manuals and certificates, a Stage 1 audit on site and then a Stage 2 audit. The Stage 2 audit is more detailed and is based on checking evidence on site against a self-completed Sustainability Key Performance Indicator (KPI) workbook and Environmental Product Declaration Questionnaire. Over 100 criteria and performance indicators for each approved supplier are audited. The audit cycle is repeated each year for each certified site. Additionally, the EPD data, which is updated once every 3 years, is subject to an additional verification stage by a third party – BRE.

As each site is audited at least once each year, the chances of data errors are reduced when compared to a sampling approach or a less frequent audit cycle.

3. What Are The Strengths Of CARES Approach?

3.1 CARES Annual Sustainability Reports

CARES collates the SCS scheme data, providing annually updated industry KPIs based on audited data from its approved suppliers and since 2011, has set sector targets for improvements which are published in CARES Annual Sustainability Reports.

The latest 2016 report[xix] covers SCS data and information from 25 producers of steel and stainless steel reinforcing bar, feedstock coil and structural steel and 11 reinforcing steel processors (fabricators).

3.2 Carbon Footprint to EPD

As a core part of the CARES SCS, CARES and thinkstep developed a carbon footprint tool, based on the ISO life cycle assessment and greenhouse gas reporting approaches, to determine the product "cradle to gate" carbon footprint for the production of 1 tonne of steel, one of CARES SCS KPIs. This enabled firms in the reinforcing steel supply chain to establish their carbon footprint data in a consistent, transparent and comparable way using the CARES Carbon Footprint Tool.

In 2013, the CARES Carbon Footprint Tool was further developed by CARES using a bespoke LCA tool developed by thinkstep using their GaBi Envision software[xx] to provide EPD to EN 15804. The CARES EPD tool has been verified by BRE Global using their EN 15804 verified EPD Scheme[xxi], and to date BRE have verified 19 EPD from reinforcing steel bar producers, alongside a sector average Verified EPD[xxii] for reinforcing bar produced using the secondary production route covering 13 CARES approved suppliers and a number of EPD for structural steel and flat steel.

3.3 Integration Of Life Cycle Thinking With Environmental Management Certification

The integration of life cycle thinking with ISO 14001 through the CARES SCS scheme has provided many benefits such as improved awareness of a broader range of sustainability issues and the ability to satisfy procurement requirements for BREEAM and green public procurement.

It enables the SCS scheme to cover traceability, responsible sourcing and life cycle assessment, with the integrated provision of Cradle to Gate carbon footprints and verified EPD to EN 15804.

3.4 Expanding The Scope Of Life Cycle Thinking To Include Social And Human Rights Impacts

Expectations from construction sector clients and other stakeholders are growing, with CARES experiencing a corresponding increase in demands for data and information on labour conditions including trafficking and forced labour, community impacts and human rights. For a more complete understanding of sustainability impacts across construction product life-cycles, responsible sourcing issues are increasingly being considered within certifications in additional to environmental impacts.

3.5 Responsible Sourcing Certification

In the absence of comparable LCA data on environmental impact for steel, the principal point of differentiation used by the UK steel industry relates to responsible sourcing.

The CARES SCS scheme has, at the date of publication, provided 25 CARES approved suppliers with certification for responsible sourcing to BES 6001, BRE Global's Framework Standard for Responsible Sourcing Scheme for construction products[xxiii]. The standard has been widely used by the steel industry, with 30% of the companies certified to the standard, producing structural or reinforcing steel products[xxiv]. These include both CARES approved producers around the world and specialised fabricators based in the UK, as well as UK steel producers such as Tata Steel, British Steel and Celsa, and other UK fabricators.

This responsible sourcing standard has a range of indicators covering management systems and environmental impacts as well as business ethics, health and safety, human rights, community and stakeholder engagement. Criteria within the CARES SCS scheme are aligned to those within BES 6001 to enable an assessment of compliance with the standard alongside an audit of the other SCS scheme elements.

3.6 Modern Slavery And Labour Conditions

BRE have recently issued its Ethical Labour Standard[xxv], driven in part by the introduction in the UK of the Modern Slavery Act 2015[xxvi]. Recent research analysing the Modern Slavery Act obligations – the publication of a statement on a company's approach to modern slavery - shows that the construction sector is some way behind sectors such as textiles/apparel and retail in approaches to due diligence and reporting on working conditions and labour issues[xxvii].

Clauses within the CARES SCS scheme go some way to provide information relevant to aspects of alleviating modern slavery. Clauses are based on the Ethical Labour Initiative Base Code[xxviii] and ILO Conventions[xxix] and require policies, codes of conduct, grievance procedures and a management system which covers the issues and annual reporting of performance information in respect of labour conditions and practices including freedom of association, working hours, forced labour, equality and other human rights issues.

One of the challenges, common to the whole steel industry, and especially relevant to some developing countries, is understanding and evaluating information on modern slavery at stages of high risk, such as the primary sourcing of scrap. The scheme scope, currently requests management and performance data and information from scrap suppliers and encourages them to do the same from their suppliers. However, it is limited in its ability to request data indirectly from all locations which are further upstream of the scrap suppliers used by certified companies.

Leading construction and infrastructure companies are requesting data and information on human rights and community impacts as well as compliance with standards and evidence of certification at the procurement stage[xxx].

Anecdotal evidence gained through industry networks and committees indicates that the integration of such information into more widely accessible formats, for example, within building information modelling systems to enable the fuller context behind building components and systems to be traced, is nascent and tends to be limited to evidence of certification to responsible sourcing schemes.

4. Steel In The Circular Economy

Steel, being reusable in many forms, as well as indefinitely recyclable without losing its properties, lends itself well to the principles of the circular economy. In Europe, recycling rates for steel arising from the demolition of buildings are high, as shown in Table 1, though the recycling rates in other sectors vary – European packaging steel is only estimated to have a recycling rate of 74%[xxxi]. Many by-products of the steel making process are also re-used in other applications, such as slag replacing natural aggregates in road building.

As the global demand for steel outstrips the availability of steel scrap, significant amounts of steel are made from primary raw materials, using the Blast Oxygen Furnace (BOF) or Direct Reduced Iron (DRI) processes.

A circular economy requires materials to be kept at the highest level of utility within a circular system. The current tendency is that it is often reused or recycled to lower grade applications (depending on the quality of the material available for reuse and recycling).

Table 1: Reuse and recycling rate for UK construction steel in 2012

Product	% Re-used	% Re-cycled	% Lost
Heavy structural sections/tubes	7	93	0
Rebar (in concrete superstructures)	0	98	2
Rebar (in concrete sub-structure or foundations)	2	95	2
Steel piles (sheet and bearing)	15	71	14
Light structural steel	5	93	2
Profile steel cladding (roof/facade)	10	89	1
Internal light steel (e.g. plaster profiles, door frames)	0	94	6
Other (e.g. stainless steel)	4	95	1
Average (across all products)	**5**	**91**	**4**

One challenge for the steel sector is being able to sufficiently reduce production based greenhouse gas (GHG) emissions in line with sector emission reduction pathways that are consistent with accepted science and legislation[xxxii]. European steelmakers have reduced energy consumption and CO_2 emissions per tonne of steel by 50% since 1960, however, they are now close to the technically feasible minimum[xxxiii].

Research from the University of Cambridge[xxxiv] and evidence from engagement with construction sector clients suggests that opportunities for emission reductions remain, by reducing demand, for instance, through product life extension, material substitution, or “light-weighting”. Importantly, working with construction clients, encouraging their architects and specifiers to consider the right size and weight for the application rather than over-specifying can significantly reduce impacts. A recent World Economic Forum report on the construction sector stated that ‘Better collaboration is needed not just between peer companies but also between companies of different types along the value chain. The current tendency is to push risk down the value chain instead of pulling innovations out of it’[xxxv].

Reusing components shows significant potential to reduce emissions particularly within construction. However, there are barriers to effective reuse including; verifying that the product or component retains its original properties, a lack of identification marking and a lack of a system to register each structural steel component so that its specification is known and can be compared to the reuse demand. Over time there is potential for systems such as building information modelling systems to support reuse. For reinforced concrete structures the barriers include the lack of an established supply chain, increased labour costs in deconstruction and the lack of reversible joining techniques[xxxvi].

5. Public Procurement Of Steel

5.1 UK Government Procurement Of Steel

In 2015, the UK Government highlighted the need, when procuring steel for major projects, to assess sustainability impacts of potential suppliers through the supply chain, including compliance with relevant health and safety and employment legislation, and to take account of these when procuring for public projects. The guidance was updated in Dec 2016 with issuance of procurement policy note 11/16[xxxvii].

Designed to provide a level playing field for UK Steel, the guidance applies to all central government departments, their executive agencies and non-departmental public bodies, who are required to comply with its terms for any major procurement project where steel is a critical component. Clause 29 within the PPN, highlights certifications such as BES 6001 and equivalents like the CARES SCS scheme, as one way suppliers can demonstrate commitment, active management and performance in relation to social and environmental impacts across the life-cycle.

Major UK public infrastructure projects like High Speed 2 (HS2), the organisation developing and promoting the new high speed rail network in the UK, are using a ‘balanced scorecard’ approach which takes account of economic, social or environmental considerations in procurement design, technical specifications, award criteria and contract performance conditions linked to the subject matter of the contract. This is in line with procurement policy note 09/16[xxxviii] and is another driver for the provision of quality LCA and social data and information in construction materials certifications.

5.2 Other Green Public Procurement For Construction And Its Use of LCA

Other countries have gone much further than the UK in requiring and using LCA data to inform procurement and funding of construction projects.

Netherlands

In the Netherlands, Rijkswaterstaat (RWS) is the Department of Public Works within the Dutch Ministry of Infrastructure and the Environment, which manages the main waterways, coastal water systems and motorways in the Netherlands. RWS aims to use green public procurement to challenge and encourage contractors and suppliers to provide added value through the delivery of sustainable working practices, green materials, energy efficiency and reduced carbon emissions.

In order to achieve these objectives, RWS uses functional specifications for infrastructure projects, together with tools to gauge bidders' commitments to reducing carbon emissions within projects and to assess the life cycle environmental impacts of the materials they propose to use. These commitments and impacts are monetised within the award phase of the tender and quoted prices are adjusted accordingly.[xxxix]

Additionally, in the Netherlands, the "Bouwbesluit 2012" (Dutch Building Code 2012), requires in article 5.9 that the greenhouse gas emissions and abiotic depletion associated with construction materials used for all new offices and housing must be quantified and reported using an agreed LCA methodology and approved Building LCA tools which comply with EN 15804 and EN 15978[xl]. Over time it is expected that benchmark limits on these impacts will be set[xli].

Germany

In Germany, the Federal Government uses BNB to assess the sustainability of all new and refurbished public buildings and this includes a Building LCA accounting for a significant part of the credit. The Government has provided the Ökobau.dat database of EPD and generic LCA data for construction products used in Germany and eTool to undertake the Building LCA, and buildings must achieve target levels to obtain credits, and must achieve a specific BNB assessment score to obtain funding[xlii].

Norway

In Norway, the Norwegian Public Roads Administration (NPRA) has over many years established procedures for impact assessments of road transport projects using cost-benefit analysis (CBA) as a central part of impact assessments to assess whether the project is viable. The NPRA uses a tool, EFFEKT, developed by Sintef, which includes a full LCA of the project to undertake the CBA.[xliii]

France

In France, the Ministry of Environment and Ministry of Housing have introduced a Regulation, "Transition Energétique pour la Croissance Verte (TECV)[xliv] which introduces the concept of "Energy positive and low carbon" buildings, and sets out the intention that all new buildings will be low carbon and energy positive from 2018. The definition of "low carbon" includes the impacts from construction materials assessed using an approved a building LCA methodology[xlv] complying with EN 15978.

6. Lessons Learnt From The Integrated Provision Of EPD, Management System And Responsible Sourcing Certifications

Addressing the need for additional assurance in public and private sector procurement, this paper provides a manufacturing sector's perspective on the lessons learnt from its integrated approach to the production of EPD alongside product, management system and responsible sourcing certifications.

Lessons Learnt

- Government and private sector expectations about the quality and availability of EPD and social data are growing. This is matched by the more than 70 EPD available for structural and reinforcing steel across Europe, covering both manufacturer specific and generic trade association declarations.
- Public procurement of infrastructure and buildings is increasingly focussing on the environmental and social impacts associated with the construction materials used and their supply chains.
- Regulation regarding the reporting of impacts associated with construction materials at the building level has been in place in the Netherlands since 2012 and France has introduced a regulation that will come into effect in Summer 2017. In both instances, maximum values are expected to be imposed in the future.
- Linking Life Cycle assessment and building information modelling systems will provide benefits in simpler assessment of LCA impacts associated with construction materials.
- Construction materials assessment should not be limited to LCA but should also include data and information on human rights, social and community impacts.
- Collaborations and engagement across the construction and building materials industries is key to achieving environmental and social performance improvements throughout the value chain
- Use of this information within certifications is one way to demonstrate compliance with and performance management improvements across the construction product life-cycle.

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