

Steel Structures: Culture & Sustainability

Istanbul, 22 September 2010

Sustainable Steel Construction

by Dr Roger Pope

Technical Consultant

to the

British Constructional Steelwork Association

and Tata/Corus Plc

Introduction

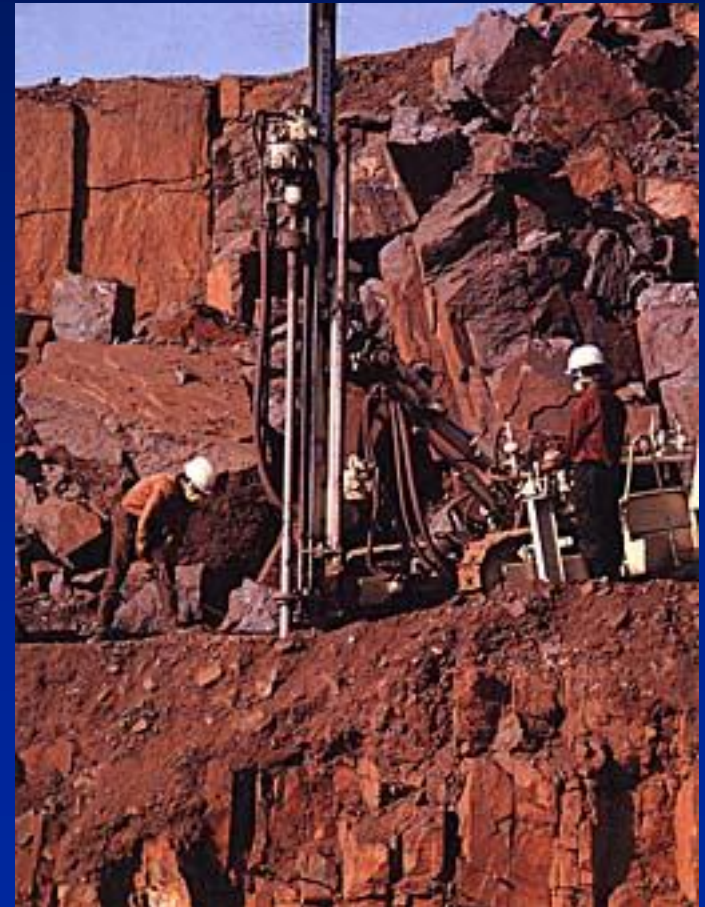
- What does sustainability mean?
- Where are we now?

Triple bottom line

- Economic (Profit)
- Social (People)
- Environmental (Planet)
 - Prudent use of natural resources
 - Reduction of waste and emissions
 - Protecting the ozone layer
 - Preventing acid rain
 - Reducing global warming potential (GWP)
 - Methane (CH₄)
 - Carbon dioxide (CO₂) => “Zero carbon” objective
 - Carbon or energy?

Prudent resource use

- Steel is 98% iron
- We live on an iron planet
 - 80% of the core
 - 5% of the crust
- No threat to sources of iron
- Responsible sourcing is the issue
 - Sustainability Charter Membership
 - Steel sourced from ISO 14001 certified steelmakers
 - Application of BCSCA/SCI carbon footprinting tool

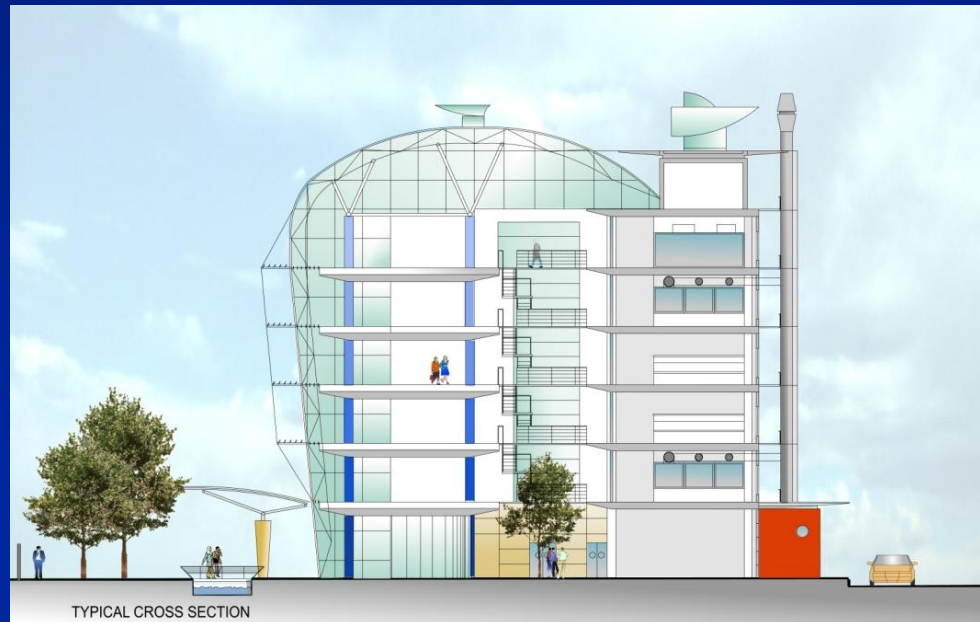


Emissions the “technical fix”

- PV, solar thermal, wind, biofuels, geothermal, nuclear
- Current global energy demand is 16TW
- To generate 13TW globally we need to construct:
- Every second for the next 25 years:
 - 100 sqm of PV
 - 50 sqm of solar thermal
 - One Olympic pool of biofuel algae
- Plus:
 - One 100m diameter wind turbine every 5 minutes
 - One 100MW geothermal steam turbine every 8 hours
 - One 3GW nuclear power plant every week
 - 24 are being built in China; 2 in the EU

Devonshire Building University of Newcastle

- BREEAM excellent
- Greywater recycling
- Energy efficient
 - Photovoltaic panels
 - Climate responsive façade
 - Passive displacement ventilation
 - Exposed thermal mass



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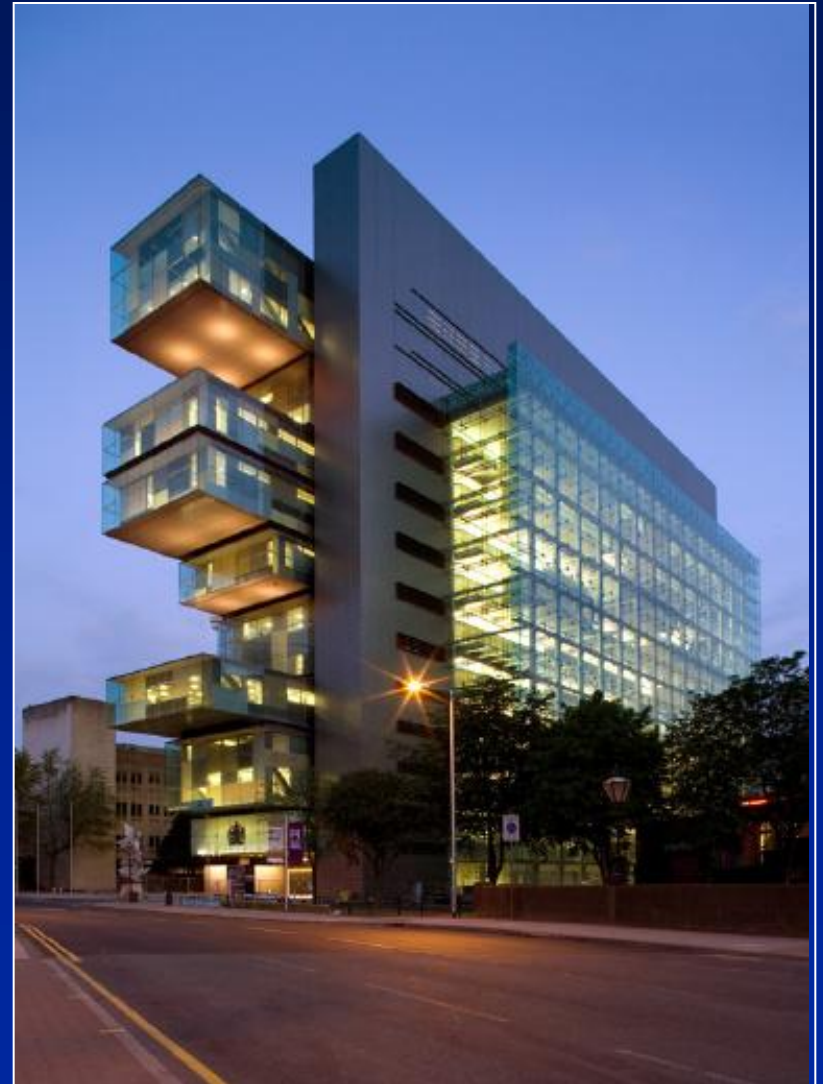
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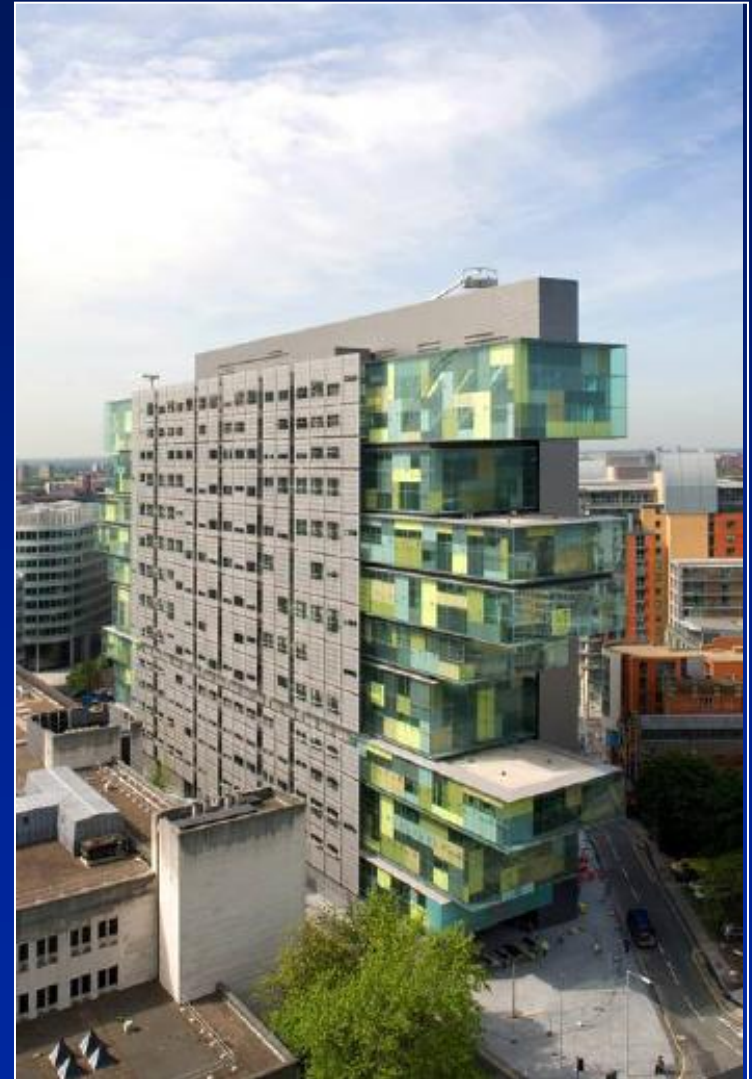
Civil Justice Centre Manchester

- Innovative and iconic
- BREEAM excellent
- Natural ventilated
- Naturally lit
- Environmental veil and light shelves
- Double-skin facade
- Borehole cooling



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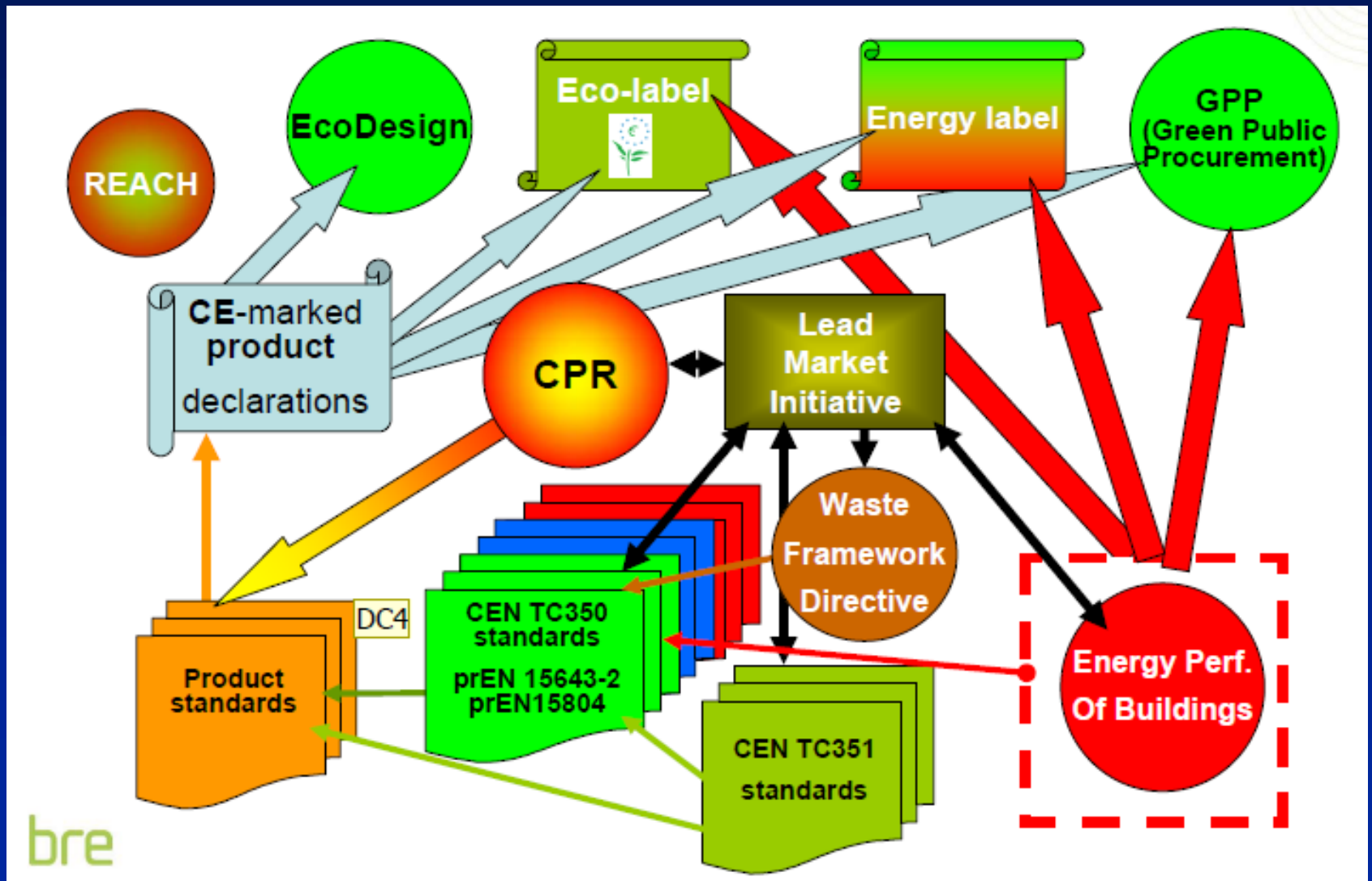
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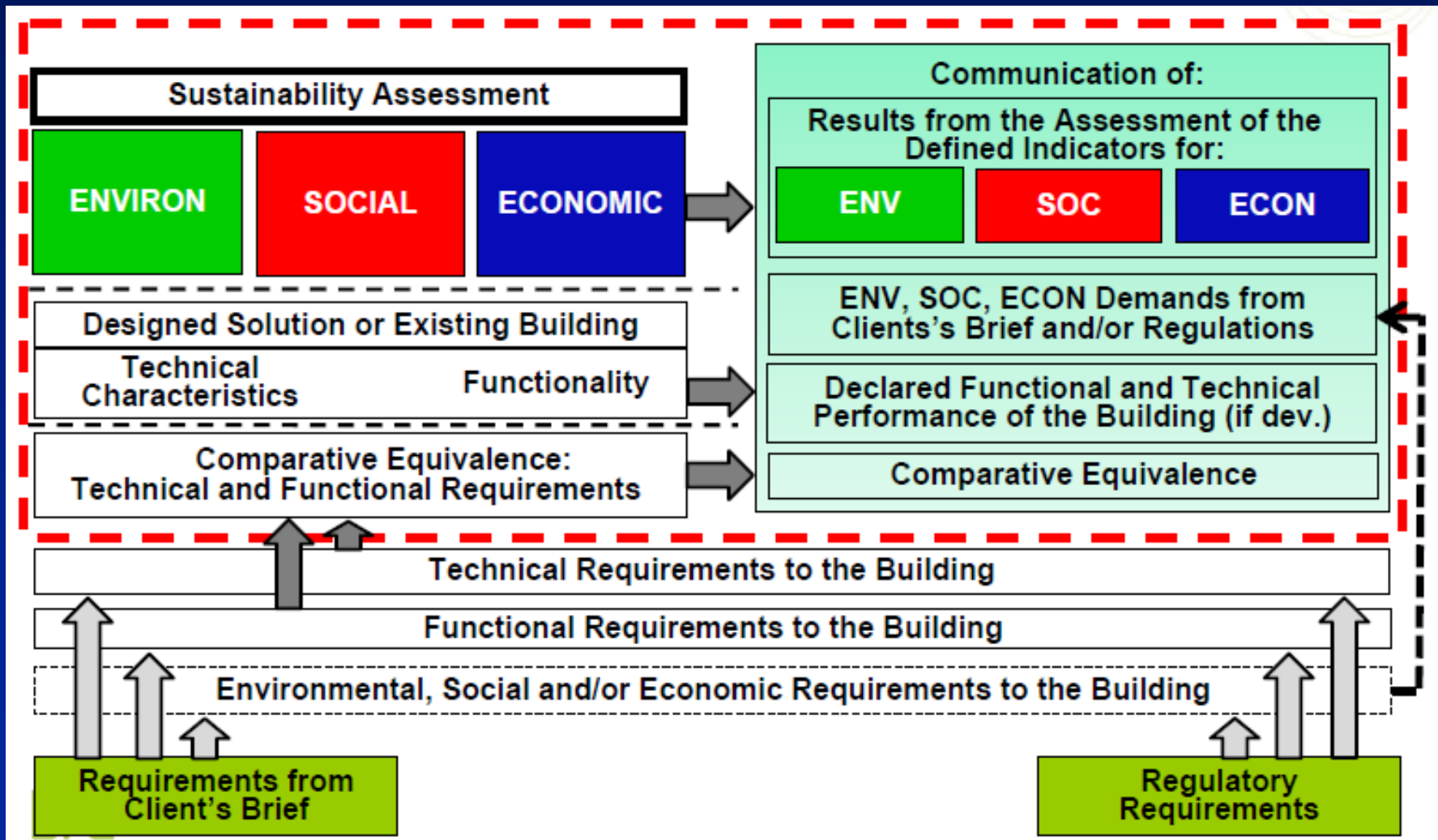
Common factors

- Pursuit of BREEAM rating
- Use of natural ventilation, natural light
- Controlled use of energy
 - Use of PV
 - Heat pumps and heat recovery
 - Focus on carbon as a measure
- Attention to water usage
- Use of steel

The maze of regulations

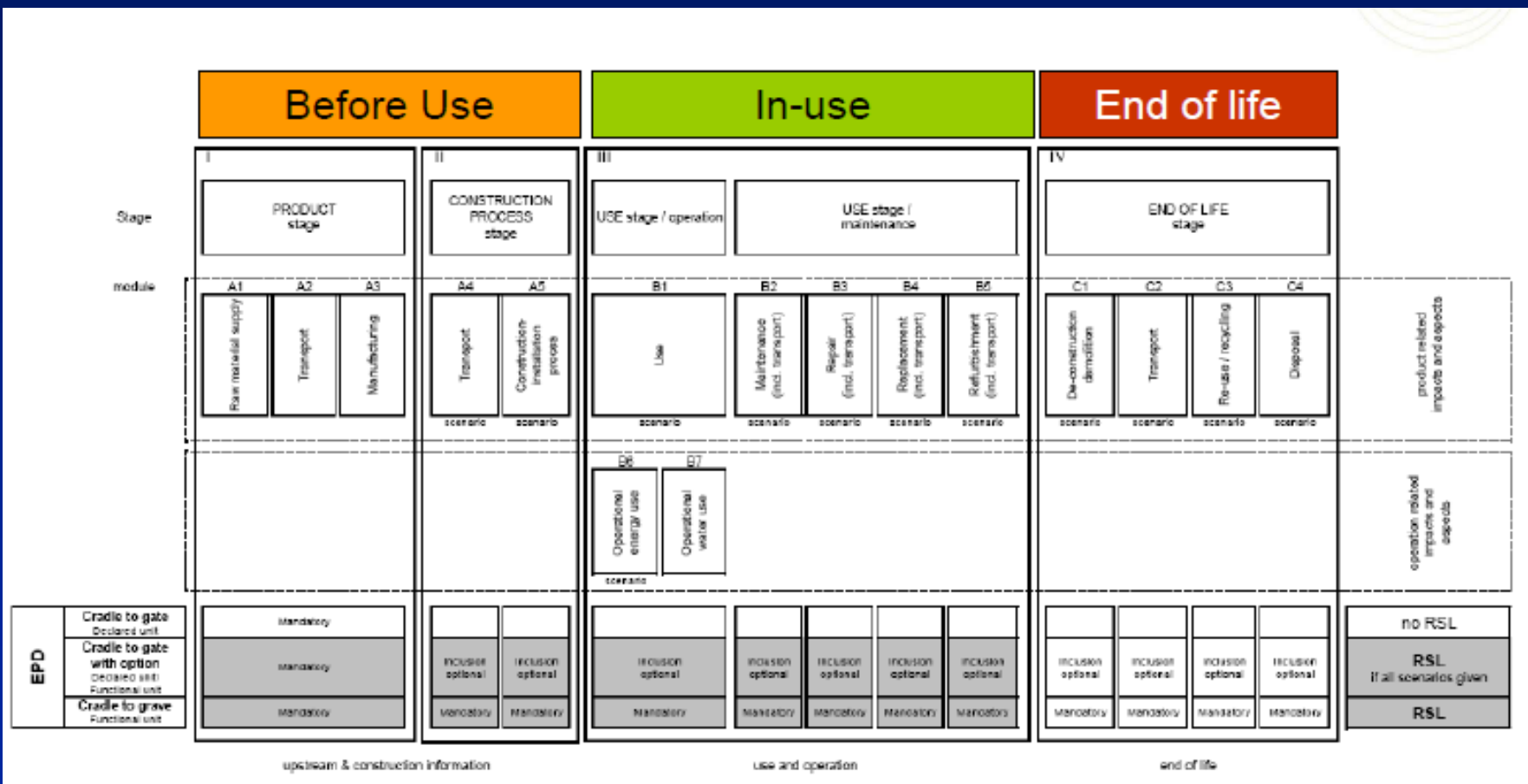


The standards



Life cycle analysis

- Information needed for EPD for product life cycle



Environmental Product Declarations

Conversion into Impact categories



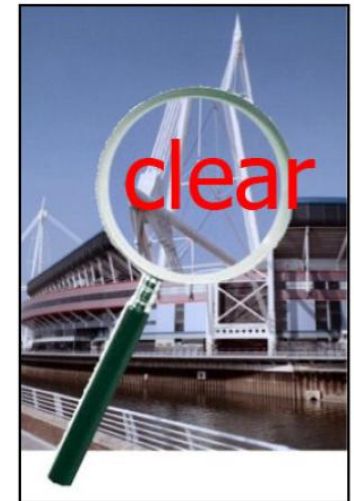
Inventory	Classification	Characterisation	Category Definition
Airborne Emissions	GWP		
Carbon Dioxide, CO ₂	CO ₂	x 1	Σ Global Warming Potential
Carbon Tetrafluoride, CF ₄	CF ₄	x 6300	
Methane, CH ₄	CH ₄	x 21	
Nitrous Oxide, N ₂ O	N ₂ O	x 310	
Other Nitrogen Oxides, NO _x	NO _x	x 7	
Sulphur Dioxide, SO ₂	AP		Σ Acidification Potential
Hydrogen Chloride, HCl			
Hydrogen Fluoride, HF		x 1	
Hydrogen Sulphide, H ₂ S		x 0.7	
Styrene		x 0.88	
Non-methane VOCs		x 1.6	
...		x 1.88	
Waterborne Emissions	PCOP		Σ Photo-chemical Oxidation Potential
...			
Waste			
...			
	CH ₄	x 0.466	Σ Photo-chemical Oxidation Potential
	Styrene	x 0.007	
	NM VOC	x 0.766	

10

CLEAR



construction
life-cycle
environmental
assessment
resource



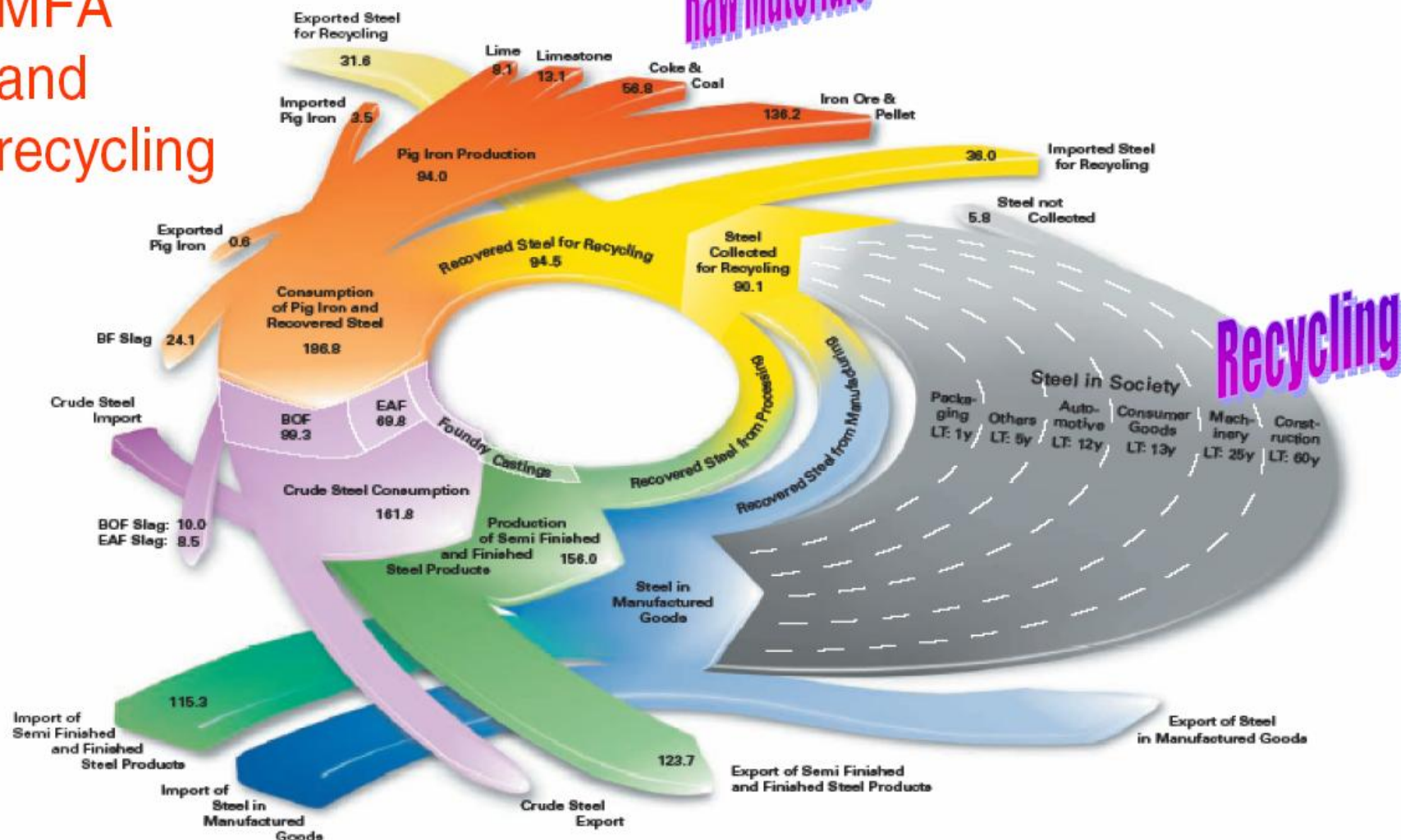
Re-usability and recyclability

- Unparalleled recyclability through multi-cycling
 - No significant deterioration of its properties

Illustration of Steel Flows in EU 15 (2004)

EUROFER
European Confederation of Iron and Steel Industries

MFA
and
recycling

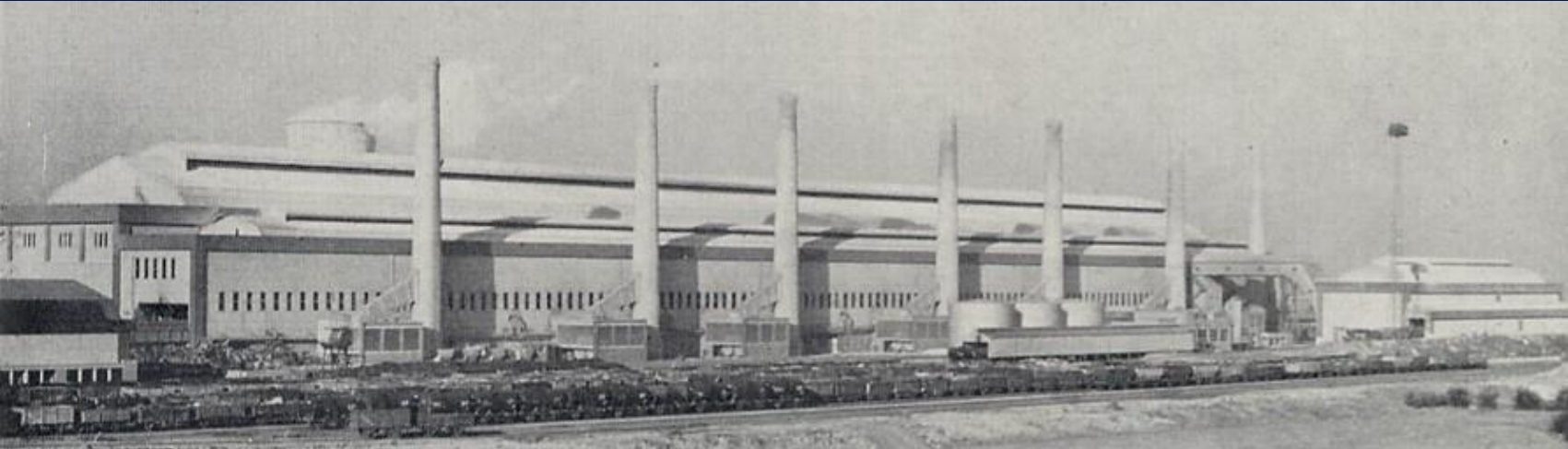


Re-usability and recyclability

- Unparalleled recyclability through multi-cycling
 - No significant deterioration of its properties
- Structural steel
 - 80% recycled as scrap charge for furnaces
 - Further 19% is dismantled and re-used directly
 - Only 1% lost to rust, dust or landfill

	Heavy profiles	Light sections	Cladding	Decking	Other
Recycled %	80	83	78	65	85
Reused %	19	17	21	15	5
Landfilled %	1	0	1	20	10

Teesside Melting Shop





Rubble or re-use?



Rubble or re-use?



Timber at end-of-life

- UK data used in BRE Green Guide:
 - From construction activities:
 - Landfill 46%
 - Incineration 5%
 - Recycling 36%
 - Reuse 13%
 - From demolition activities:
 - Landfill 58%
 - Incineration 6%
 - Recycling 23%
 - Reuse 13%
- Methane from landfill
 - An atmospheric lifetime of 12 ± 3 years
 - GWP of 72 over 20 years or 25 over 100 years

Fabric energy storage



“Thermal mass”



Fabric energy storage

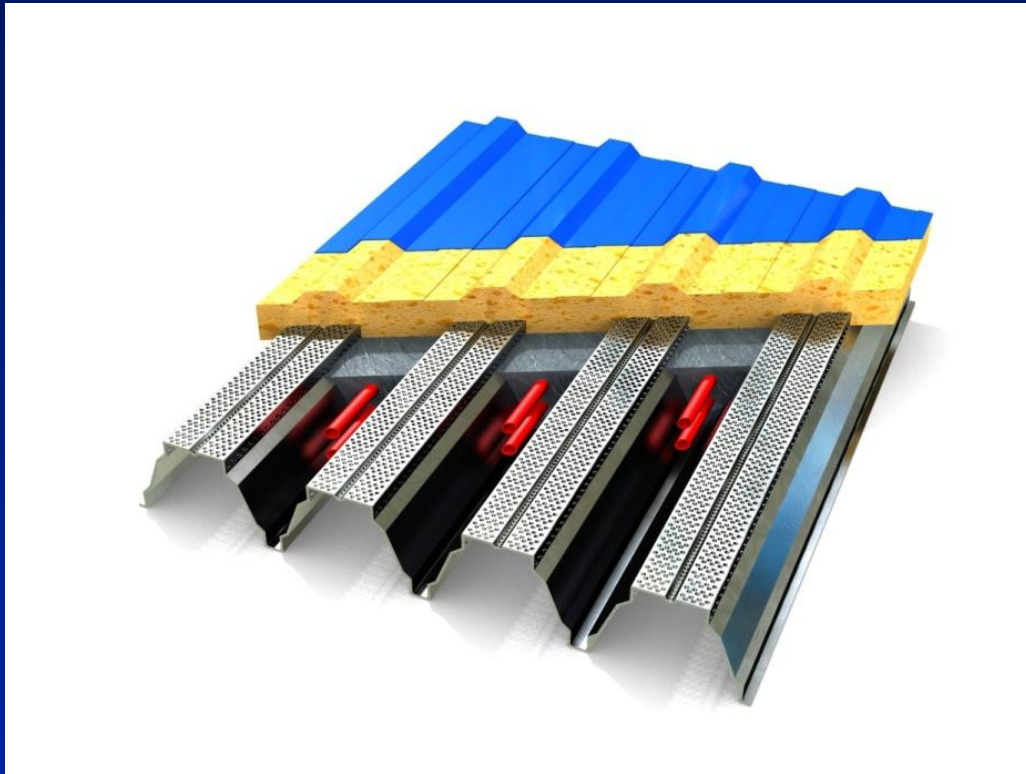


Active fabric energy storage



Active fabric energy storage

E=mc² system Ecological Multifunctional Climate Ceiling





TARGET ZERO

ISSUE 2

KEEPING YOU UP-TO-DATE



Corus is Europe's second largest steel producer. With main steelmaking operations primarily in the UK and the Netherlands, Corus supplies steel and related services to the construction, automotive, packaging, mechanical engineering and other markets worldwide.

Corus is a subsidiary of Tata Steel, one of the world's top ten steel producers. The combined enterprise has an aggregate

crude steel capacity of more than 28 million tonnes and approximately 80,000 employees across four continents.

With innovation and continuous improvement at the heart of its business performance, Corus aims to create value by offering a differentiated product range supported by unrivalled customer service.

www.corusconstruction.com

Target Zero is a programme of work, funded by Corus and the British Constructional Steelwork Association, to provide guidance on the design and construction of sustainable, low and zero carbon buildings in the UK. Five non-domestic building types are being analysed: a secondary school, a distribution warehouse, an out-of-town supermarket, a medium-to-high rise office and a mixed-use building.

Key findings

The Target Zero methodology is to modify the design parameters of a recently constructed building to define a baseline that just meets the 2006 Part L minimum requirements for operational carbon emissions. In this study the baseline building is significantly less energy efficient than the actual building on which it is based. The baseline building is then used as a benchmark to assess the impacts and costs of introducing a range of sustainability measures to meet the likely future low and zero operational energy targets, the higher BREEAM ratings and improvements in embodied carbon.

Lighting efficiency
Lighting was found to be the most significant use of operational energy. For the Part L 2006 compliant baseline warehouse, a 37% reduction in regulated carbon emissions can be achieved by using a more efficient lighting system.

Compatible energy efficiency measures
The report demonstrates how it is possible to implement a package of compatible,

cost-effective energy efficiency measures to yield a 54% reduction in regulated emissions, relative to the Part L 2006 compliant baseline warehouse. Such a package could yield a 25-year net present value saving of -£2,470,354.

BREEAM

The estimated capital cost uplift of the baseline warehouse for achieving the following three BREEAM assessments is:

- 0.04% to achieve BREEAM 'Very Good'
- 0.4% to achieve BREEAM 'Excellent'
- 4.8% to achieve BREEAM 'Outstanding'

Embodied Carbon

The structural solution for the baseline warehouse was a four span steel portal frame. A pre-cast concrete and glulam framed warehouse was found to have a 14% higher embodied carbon impact than the baseline warehouse.

The full report can be downloaded from www.targetzero.info

Warehouse Guidance

The new warehouse guidance provides invaluable information for designers, construction clients and their professional advisors on how to design and construct sustainable warehouses.



The Target Zero Warehouse is based on a recently constructed building, ProLogis Park in Stoke-on-Trent, which has been leased to a large UK retailer and has achieved both BREEAM 'Excellent' and an EPC 'A' rating. Therefore, the building's template, together with Target Zero's recommendations for similar projects, will provide a generic set of best practice guidelines for others to use.



The British Constructional Steelwork Association Limited (BCSA) is the national organisation for the steel construction industry. Member companies undertake the design, fabrication and erection of steelwork for all forms of construction in buildings and civil engineering. Associate Members are those principal companies involved in the direct supply to all or some Members of components, materials or products.

The principal objectives of the association are to promote the use of structural steelwork, to assist specifiers and clients, to ensure that the capabilities and activities of the industry are widely understood and to provide members with professional services in technical, commercial, contractual, quality assurance and health & safety matters.

www.steelconstruction.org

AECOM, the global provider of professional technical and management support services to a broad range of markets; including transportation, facilities, environmental and energy, is project managing the Target Zero initiative.

It is leading on the structural, operational energy and BREEAM elements of the

project. AECOM is investigating how operational energy use can be reduced through good design and specification of low and zero carbon technologies. It is also applying BREEAM to each of the solutions and advising how 'Very Good', 'Excellent', and 'Outstanding' BREEAM ratings can be achieved at the lowest cost.

www.aecom.com



Cyril Sweett is a leading international construction and property consultancy offering expertise in cost consultancy with a strong knowledge of the costs and benefits of sustainable design and construction. Cyril Sweett worked closely with AECOM on all parts of the project to provide fully costed solutions. This included the analysis of the BREEAM aspects of the project to determine how 'Very Good', 'Excellent' and

'Outstanding' ratings can be delivered at the lowest cost.

Cyril Sweett is unique within the industry as the majority of our staff own shares in the business. We believe this helps build a sustainable and profitable business, providing careers, personal development and opportunities over the long-term.

www.cyrilsweett.com



SCI (The Steel Construction Institute) is the leading, independent provider of technical expertise and disseminator of best practice to the steel construction sector. We work in partnership with clients, members and industry peers to help build businesses and provide competitive advantage through the commercial application of our knowledge. We are committed to offering and

promoting sustainable and environmentally responsible solutions.

The SCI is supporting AECOM with the operational energy and BREEAM work packages and is responsible for developing design guidance based on the research.

www.steel-sci.org

Register at www.targetzero.info to access all the latest Target Zero resources and receive email notifications when new guidance reports become available.



The next Target Zero guidance dates are as follows:

Warehouses	May
Retail	July
Offices	Sept
Mixed Use	Nov

Register at www.targetzero.info and receive email notifications when new guidance reports become available.

Warehouse

ProLogis Park, Campbell Road, Stoke



As a leading provider of industrial and distribution warehouses, ProLogis designs all new buildings to achieve a BREEAM 'Excellent' accreditation and for all buildings over 150,000 sq ft, it aims for an Energy Performance Certificate (EPC) 'A' rating.

By applying robust design guidelines to each new facility, ProLogis delivers consistently high quality buildings that not only help cut occupational costs, but can also reduce the customer's carbon footprint.

DC3, a 362,000 sq ft distribution warehouse at ProLogis Park Stoke, which has been let to Marks & Spencer has achieved both BREEAM 'Excellent' and an EPC 'A' rating. Therefore, the building's template, together with Target Zero's recommendations for similar projects, will provide a generic set of best practice guidelines for others to use.



Retail

Asda, Stockton on Tees



All of Asda's stores follow a comprehensive energy efficiency programme, which includes identifying renewable sources of energy to power its stores and depots.

In its existing stores, Asda is on target to reduce energy consumption by 20% by 2012 (compared to measurements taken in 2006). Asda is also committed to ensuring that all of its new stores use 30% less energy by the end of 2009, through the use of new building techniques and materials.



Office

One Kingdom Street, London

Part of PaddingtonCentral, this 265,000 sq ft office accommodation designed by Shappard Robson was completed in February 2008.

PaddingtonCentral has itself become widely recognised as a market leading development, achieving a BREEAM rating of 'Excellent'. Within the scheme, One Kingdom Street, London has also established new standards in sustainable construction practices and particularly waste management.



PaddingtonCentral



Mixed use development

MediaCityUK, Manchester



The studio block in the £500 million MediaCityUK development by Boffis Lundness for Peel Holdings forms the starting point for the Target Zero mixed use development.

Due for completion in 2011, Phase 1 of the development consists of 65,032 m² of office space; 7,432 m² retail space; a high capacity car park; two residential towers; and a five acre public realm area.

With numerous facilities, specifiers and developers of mixed use schemes need to deliver buildings that cater for a diverse range of needs. Target Zero's approach will provide guidance on how to achieve this without compromising environmental impact.

What is Zero Carbon in buildings?



The Government has announced its aspiration for new schools to be zero carbon by 2016 and is consulting on the definition of 'zero carbon' for non-domestic buildings.

The Government supports a hierarchical approach to meeting a zero carbon standard for buildings and prioritises in turn:

- **Energy Efficiency measures** - to ensure that buildings are constructed to very high standards of fabric energy efficiency and use efficient heating, cooling, and lighting systems. The current proposal following the precedent set for domestic buildings is to set a standard for energy efficiency based on the delivered energy required to provide space heating and cooling. The level for this standard has currently not been set for non-domestic buildings.

- **Carbon Compliance** on or near-site - this is the minimum reduction in carbon dioxide emissions required compared to the 2006 Part L requirements. The levels of contribution from on-site energy generation (or directly connected heat) have been modelled as part of the Government's consultation on zero carbon non-domestic buildings. The results for 11 building types show a range between 13% (supermarkets), through to 86% (hotels) and even 100% improvement (warehouses) on 2006 standards.

- **Allowable Solutions** - a range of additional beneficial measures to offset 'residual emissions', for example exporting low carbon or renewable heat to neighbouring developments or investing in L2C community heating.

The Government also proposes that the zero carbon target for non-domestic buildings will include both regulated and unregulated energy use. There is a proposal that a flat rate allowance for the unregulated energy use in a building could be set as an additional 10% or 20% improvement over the regulated energy use.





Warehouse technical lighting and rooflights



Lighting was found to be the most significant energy demand in the basecase warehouse building¹ studied, accounting for around three quarters of the total operational carbon emissions. Consequently, efficient lighting systems coupled with optimum rooflight design were found to be key in delivering operational carbon reductions.

The effect of rooflight design on the operational carbon emissions of a building is complex. Rooflights impact both the heating and lighting requirements in different ways and at different times of the day and year; they also affect overheating. The basecase building has rooflights which cover 15% of the total roof area, which is towards the upper end of what is typical for new warehouse buildings in the UK, i.e. 10% to 15% of roof area.

The optimal rooflight design for a warehouse building will vary depending on the final use and internal layout of the warehouse. Most new warehouse buildings are built speculatively, meaning that the design team does not know the final use of the building or the internal configuration of racking, equipment, etc.

The use of high bay shelving or racking has a major impact on the efficiency of both natural and artificial lighting in

LZC technologies

used within Target Zero studies

Target Zero assesses the impact of installing a number of low and zero carbon technologies. The following articles provide a basic introduction to the types of technology considered within the project.

Fuel cells

Fuel cells are energy conversion devices that produce electricity from the energy contained in a fuel. Like batteries, they produce direct-current (DC) electricity, but, like engines, they are refuelled (by filling a fuel tank), rather than being recharged with electricity.

Fuel cells are not a "green" technology in themselves, but in theory fuel cells can be very efficient at converting chemical energy contained in a fuel into electricity. This means that up to two-thirds of the energy contained in a fuel (sometimes more) can be recovered as electricity, the rest being converted to heat.

Biomass

Biomass is one of the oldest sources of energy used by humans – ever since we started using fire, we have been using bioenergy in some way. One of the ways in which the energy captured in biomass can be directly released is through burning the material, which provides heat (e.g. via steam or hot water), electricity or both when used in conjunction with Combined Heat and Power systems.

Ground source heat pumps

Ground source heat pumps exploit solar heat absorbed in soil close to the surface. A ground source heat pump circulates fluid around a loop of pipe (called a ground loop), which is buried in the ground. Heat from the ground is absorbed into this fluid and is pumped through a heat exchanger in the heat pump. Low-grade heat is then extracted by the refrigeration system and, after passing through the heat pump compressor, is concentrated into a higher temperature useful heat capable of heating water for the heating and hot water circuits of the building. Ground loop fluid, now cooler, passes back into the ground where it absorbs further energy from the ground in a continuous process while heating is required.

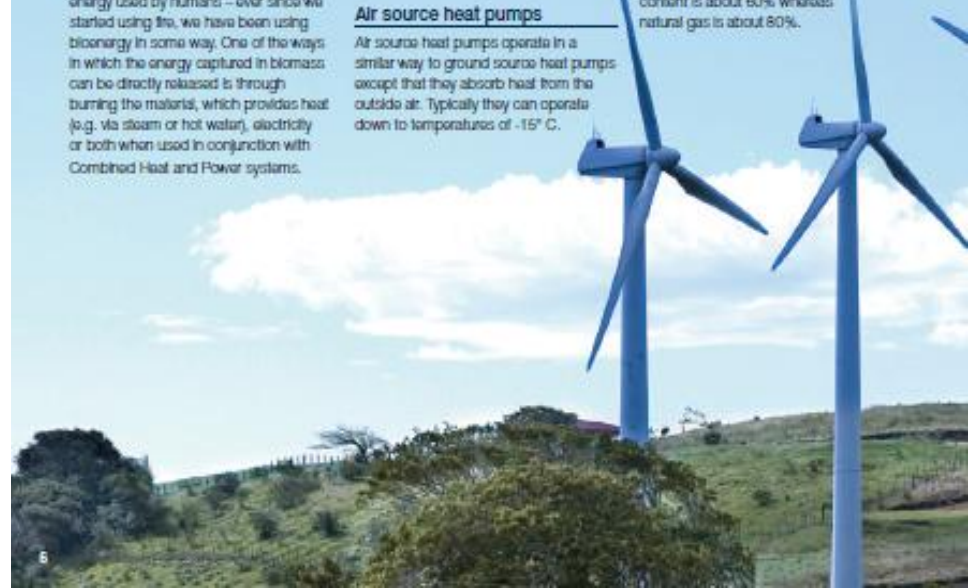
Air source heat pumps

Air source heat pumps operate in a similar way to ground source heat pumps except that they absorb heat from the outside air. Typically they can operate down to temperatures of -15°C.

In an air source heat pump, heat from the air is absorbed into a fluid that is pumped through a heat exchanger in the heat pump. Low-grade heat is then extracted by the refrigeration system and, after passing through the heat pump compressor, is concentrated into a higher temperature useful heat capable of heating water for the heating and hot water circuits of the building.

Anaerobic digestion

One way to convert organic waste to energy is anaerobic digestion, which is a process where bacteria break down organic material in the absence of oxygen. This produces a methane-rich biogas that can be burnt to generate electricity and/or heat. Biogas methane content is about 60% whereas natural gas is about 80%.



¹The basecase building was defined based on an actual distributor warehouse, i.e. based on the same dimensions, specification, etc. Changes were then made to the fabric and services of the actual building to provide a basecase warehouse that is representative of current practice and just complies with the requirements of Part L (2009).

The carbon footprint of steel

To accurately establish the environmental impact of steel manufacture, the World Steel Association (worldsteel) uses the 'system expansion' method of life-cycle assessment. This is the most comprehensive assessment method currently available and is the preferred approach of the ISO 14040 series of environmental standards. The values in the table have been derived from an extensive dataset collected by worldsteel using the 'system expansion' method.

It is standard practice to express carbon and energy impacts on a per tonne basis, which can give the false impression that steel has higher impacts than other construction materials. However, steel has a high strength-to-weight ratio, which means that the weight of steel required for a given application is often much less than for alternative construction materials.

There are other values in circulation from a variety of sources. Some are higher and some are lower than those quoted in the Table. They are often derived from limited 'cradle to gate' analysis that consider the first manufacture and use of a product, but ignore the impacts or benefits associated with the treatment of a product at the end of its life. Highly recycled materials, such as steel (see attached recycling flow figure), are penalised by a simplified 'cradle to gate' analysis, whereas materials that are predominantly disposed of as waste at the end of their first life, such as timber, can be advantaged. This is clearly contrary to environmental good practice. The 'system expansion' method considers the full product life-cycle from 'cradle to grave'.

An example of the calculation method for the carbon dioxide emissions associated with steel production can be viewed at www.corusconstruction.com/sustainability

Carbon and energy impacts of steel construction products in the UK

	Plate	Sections	Tubes	Hot Dip Galvanised (gypsum)	Castings & Cast Parts
CO ₂ (kg)	0.819	0.750	0.887	1.360	1.100
Energy (kWh)	17.27	15.12	16.42	21.83	18.36

The natural recycling flow of steel

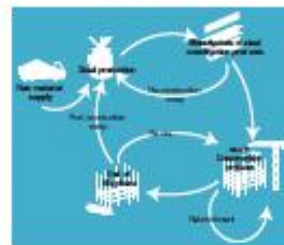


Photo courtesy of Tim Crocker



Corus pilot plant could dramatically reduce steel industry emissions



Corus is to test a potentially ground-breaking new iron-making technology in a pilot plant project at its IJmuiden steelworks in the Netherlands.

Called 'H-beams', the technology will consume significantly less coal than conventional technologies, which, along with other increased efficiencies achieved by removing the need for sinter and coke, could result in a 20% reduction in CO₂ emissions compared to the current blast furnace route.

The £20 million project is one of the initiatives that has sprung up under the auspices of ULCOSS (Ultra Low CO₂ Steelmaking), a consortium of European steelmakers that has drawn up the world's most advanced programme to reduce the steel industry's carbon footprint.

The 60,000 tpa H-beam pilot plant will be commissioned at the end of 2010, after which an intensive test programme will be carried out, supported by all ULCOSS partners.



Steel is the responsible business choice



Sustainability is high on the agenda for most companies today and implies a focus on a responsible practice across an organisation's activities and all along the supply chain.

It is this responsible approach, that is a common thread throughout the constructional steelwork supply chain, and sees constructional steelwork as an increasingly sustainable material of choice for responsible clients and designers. Signing up to the BCSA's Steel Construction Sustainability Charter (SCSC) is one initiative that offers steelwork contractors a way of demonstrating that they are addressing sustainability at a time when clients are becoming increasingly aware of the issues and seeking to employ firms who can show that they are monitoring their progress and making improvements in this area.

The SCSC was set up to promote the development of steel as a sustainable form of construction in terms of economic viability, social progress and environmental responsibility. Steelwork contractors demonstrate their commitment to operating in a sustainable and responsible way by signing up to the Charter.

There are three levels of status in the Charter – Member, Silver and Gold, and applicant companies agree to their

sustainability credentials being assessed and monitored. The status achieved depends on the number of points scored following assessment. The BCSA requires Charter Members to formally declare to operate in sustainable ways that work towards:

- Adding value to clients and stakeholders
- Optimising the eco-efficiency of the steel construction life cycle
- Promoting resource and energy efficiency in steel construction through re-use and multicycling
- Operating in a healthy, safe and environmentally sound manner
- Having high ethical standards
- Implementing sustainable development by constructive dialogue and enhancing knowledge of sustainability
- Demonstrating social responsibility by promoting values and initiatives that show respect for people and communities associated with steel construction and with other organisations in the supply chain.

Benchmarking key performance indicators (KPIs) are being developed by the BCSA, not only to measure the progress of sustainable development in steel construction but to demonstrate genuine commitment.

Charter Member companies are assessed against the criteria listed below; to obtain Charter membership companies must achieve at least six of the requirements; for Silver a minimum of nine requirements must be met and for Gold all requirements must be met.

- A published sustainability policy (mandatory)
- Monitoring of progress towards sustainability using specific management targets
- A programme of involvement with their local community on social issues and with the steel construction community generally
- An accredited HASMS to OHSAS 18001 or HAS management as an integral part of the OHS accredited to BS EN ISO 9001
- IP accreditation or a structured programme for personnel training, development and communication
- A published equal opportunities policy
- A published ethical trading policy
- An accredited EMS to BS EN ISO 14001
- Use of environmental impact assessment for process improvement
- A policy to manage energy and vehicle fuel usage in the business
- A policy to question whether suppliers have published sustainability policies
- An accredited CMS to BS EN ISO 9001



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Sustainable Steel Construction

- Natural resource use is about responsible sourcing
- Steel can be multi-cycled
- Steel buildings can have low embodied carbon and can be “zero carbon” in operation
- Design quality in steel is innovative and visibly high
 - Good engineering properties which maximise performance
 - Quick and efficient construction
 - Off-site manufacture with low waste
 - Steel construction is the safe solution
- Steel buildings “tread lightly on the ground”
- Steel buildings are ideal for adaptability and re-use
- A steel building is a “warehouse of its parts”
- Steel construction is well-placed with a responsible attitude towards its obligations

STEEL – The legacy material of choice

